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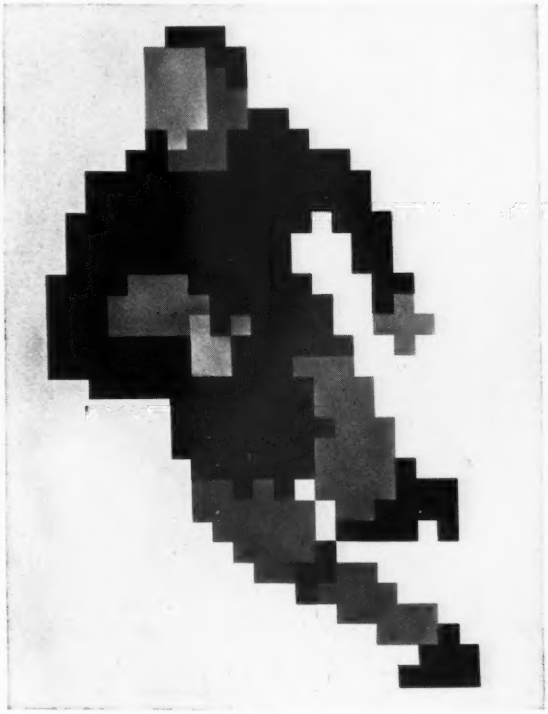

A synthetic television image of about eleven hundred elements

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Keystone View Company

Sir Chandrasekhara Venkata Raman, Nobel Laureate

By C. J. DAVISSON
Research Physicist

IN AWARDING the Nobel Prize in physics for 1930 to Sir C. V. Raman, the Swedish Academy concurred with physicists the world over in appraising the discovery of the "Raman effect" as one of the most important achievements in physics in recent years.

As on some previous occasions, the award this time is made, nominally at any rate, for a single experimental result of striking importance. Again as on previous occasions, the particular experiment to receive this signal recognition is a rather simple one—one which might have been made with equipment at hand in almost any physical laboratory in the world at any time during the last forty or fifty years. Indeed, within a year of Raman's announcement of his discovery, the effect was verified and studied by more than forty investigators in countries other than India.

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In its simplest form the experiment consists in irradiating a transparent substance with monochromatic light, and observing the spectrum of the light which the substance scatters. Raman found that the scattered light comprises, in addition to a line of the same wave-length as the incident radiation, a few much fainter lines as well, which additional lines are in a sense satellites of the primary line, moving with it as a group through the spectrum when the wave-length of the primary radiation is altered.

In the first definitive experiment of this kind, Raman photographed the spectra of the radiation scattered by various organic compounds when illuminated by a part of the spectrum of a mercury arc. On long exposure the plates revealed these additional or secondary lines not present in the primary light. It was found possible to classify these secondary lines into groups each associated with a single one of the primary lines; corresponding members of the various groups are displaced in frequency each by the same amount from its primary. The different groups may overlap in the spectrum, making the sorting out difficult but not impossible. A group may extend on both sides of the primary; as a rule more and stronger lines are found on the side of lower frequencies. Such lines as do appear on the high frequency side are found always to be matched by lines of equal displacement on the low frequency side. It is as if the scattering material has at its disposal a small collection of frequencies which it can add to that of the incident light or subtract from it, and as if it prefers subtraction to addition. These simple numerical relationships distinguish the Raman effect from the somewhat similar phenomenon of fluorescence — these and the fact that the Raman effect appears to be a universal phenomenon observable with any transparent medium gaseous, liquid or solid, whereas fluorescence is exhibited by a limited class of materials only.

The simple numerical relationships which have been mentioned as characteristic of the Raman effect, and one other which is to be described further on, are easily explained in terms of light quanta and the known properties of molecules. This is one of the reasons for regarding the discovery of the Raman effect as an event of great importance; it makes an addition to the list of phenomena which are conveniently interpreted by regarding light as a corpuscular as well as a wave phenomenon.

Since Einstein in 1906 rehabilitated the corpuscular theory of light to explain the photoelectric effect, and more especially since the discovery of the Compton effect in 1924, it has become steadily more imperative to recognize that light has these two apparently irreconcilable aspects; a beam of light is a flight of particles or a propagation of trains of waves, depending upon the particular phenomenon which is to be explained or visualized. In explaining some phenomena it is even necessary, or at least convenient, to oscillate between the two views at different stages of the argument. In such cases translation from one to the other is made by means of two well established laws: the energy of the light particles or photons is strictly proportional to the frequency (waves per second) of the associated undulations, and similarly the momentum of the photons is strictly proportional to the wave number (waves per centimeter) of the undulations. The factor of pro-

portionality is in both cases the so-called Planck constant h.

In the corpuscular explanation, the Raman effect is due to interchanges of energy occurring in encounters between photons of the incident light and molecules of the scattering material. Photons emerge from these encounters with altered energy; they constitute the scattered light of altered frequency and altered wave-length which Raman detected. Now every kind of molecule or atom has the following peculiar property: its internal energy is limited to certain definite discrete values. The molecule is capable of existence only at certain "energy levels," and can accept or give up energy only in amounts which will raise or lower it, from the particular level in which it happens to be, to another of its levels.

Thus the photons may give up to the molecules only one or another of these characteristic amounts of energy, and, in consequence of the direct proportionality between energy and frequency, the frequency of the associated waves should be lowered only by corresponding amounts. It is for this reason that the Raman spectrum is a spectrum of sharp lines. The frequency displacements in the Raman spectrum should correspond to differences between energy levels of the molecules; and in cases in which these latter are already known, this relationship is verified.

The Raman lines on the high frequency side of the primary line may be explained on the general principle that processes of the kind mentioned in the last paragraph are necessarily reversible. If it is possible for a photon to give up a part of its energy in raising a molecule from one level to another, it must be possible also for the molecule in passing in the opposite direction to impart an equal amount of energy to a colliding photon. This process is the analogue of what is known in encounters between electrons and atoms as a "collision of the second kind." The presence of high frequency components in the Raman spectrum symmetrical with the low frequency components is due to such encounters. These components are weaker than their companions because at ordinary temperatures nearly all of the molecules are in their state of lowest energy and are incapable therefore of imparting energy.

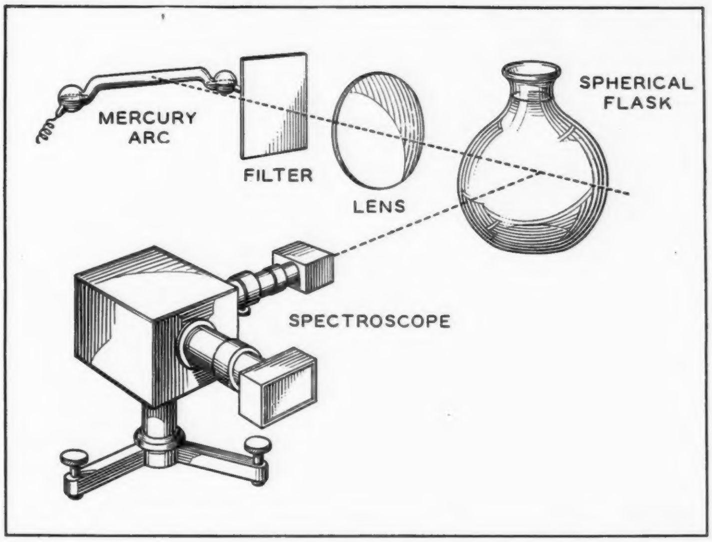
Thus, the importance of Raman's discovery is due partly to its revealing a previously unknown process in nature, partly to the additional basis of reality which it affords to the photon, and partly to its supplying a new and convenient method of investigating the energy levels of molecules.

It was remarked earlier on that the Raman experiment is a rather simple one which might have been made with equipment available in any physical laboratory at any time in recent decades. It was no accident, however, that this particular discovery was made by Raman rather than by somone else. Important discoveries in physics, even quite simple ones, are usually made only by investigators who have cultivated intensively the particular field concerned, and this is strikingly true in the present instance. No one else in recent years has been as assiduous in the study of the scattering of light as Professor Raman. True, in the years just following his graduation from Presidency College, Madras, in 1907, his interest—if we may judge from his publications—centered chiefly in the vibrations of mechanical systems—stringed musical instru-

ments in particular — and other acoustical problems. But even in these years problems in optics claimed a part of his attention. About 1920, however, —three years after he became Sir Taraknath Palit Professor of Physics at Calcutta University—he turned abruptly from studies in acoustics and devoted himself almost exclusively to optics and particularly to investigations of scattering, both theoretical and experimental. Of one hundred papers and notes published by Raman independently or in collaboration with his associates and students since that time, eighty-three deal with problems in optics and forty-nine of these with the scattering of light.

It speaks well for the development of science in India that Professor Raman apparently owes little or nothing of his eminence to direct contact with physicists in other countries. His formal training was received entirely in India, and, except for a single year, he has worked only in his native land. In 1924 he attended the Toronto meeting of the British Association and afterwards carried on his researches for some months at California Institute of Technology.

His previous honors, which have been numerous, include the general presidency of the Indian Science Congress and fellowship in the Royal Society. Knighthood was conferred upon him by King George in 1929. India may well be proud of Sir Chandrasekhara Venkata Raman, her first Nobel Laureate in science.



Schematic representation of the apparatus used by Raman in his early experiment

Quality of Television Images

By D. K. GANNETT
American Telephone and Telegraph Company

IN THE processes usually employed in telephotography, the picture may be considered to be divided into a large number of small, equal-sized elements like a mosaic. Unlike the human eye, which sees the whole picture at once, the electrical eye of the transmitting machine is focussed on only one element at a time, passing rapidly along row after row of elements until the whole picture has been scanned. As each element is viewed in turn, an electrical signal is sent out whose strength corresponds to the average shade of that element. Upon reception of the signals, the receiving apparatus recreates the picture elements one at a time, painting each dark or light as directed by the electric signals, and arranges them in the proper order to form a picture similar to that viewed by the transmitter.

It is apparent that in such a system, picture details smaller or closer together than the size of one picture element cannot be properly transmitted. The finest details which may be sent are such as would make alternate picture elements dark and light. The electric signals which would be sent out as these elements are transmitted would be alternately strong and weak, a cycle being sent for each two elements. The frequency of this current would therefore be the number of picture elements being sent per second divided by two. Where the detail is coarser, the frequency would be lower.

It is necessary, therefore, to be able to transmit from the sending to the receiving apparatus all frequencies up to that corresponding to the finest detail — a frequency equal to the number of picture elements per second divided by two. If the wire line or the radio channel over which the currents are sent cannot transmit as high a frequency as this, the received picture will appear coarser, just as though the picture had been divided into larger elements in the first place. No matter how nearly perfect the sending and receiving apparatus, therefore, no better picture can be received than that permitted by the frequency band which can be sent from the sending to the receiving point.

This is true equally of telephotography and of television. The principal difference between the two is in the speed of transmission. In telephotography, several minutes may be taken to transmit a picture, but in television, as in moving picture projection, it is necessary to present to the observer about 16 complete pictures per second, in order to give the illusion of motion. This means that each picture can contain only the detail which can be transmitted in 1/16 of a second.

Suppose, for example, that an ordinary 10-kc. radio broadcasting channel is to be used for television purposes. With the usual broadcasting methods, the total channel width is divided between two sidebands which are transmitted from the radio trans-

mitter so that the highest frequency which would be transmitted to the television receiving apparatus from the radio receiving set is determined by the width of one sideband, which is 5000 cycles. Since each cycle represents two picture elements, the number of picture elements which could be received is 10,000 in a second, or 625 in 1/16 of a second. No matter how good the television apparatus, therefore, no better quality picture could be obtained than one containing 625 elements, or about 22 by 28 elements.

Television pictures of about this quality are illustrated in the pictures in Figure 2, showing a portrait, a single figure and a group of figures as they would appear when sent over an ordinary radio broadcasting channel. These may be compared with the photographs of Figure 1, which show how the portrait and the group in the prize-fight ring appear when divided into 250,000 elements instead of only some 625. To broadcast such pictures as television images would require a frequency band 4,000,000 cycles wide — equivalent to 400 ordinary broadcast channels. It will be seen that the pictures in Figure 2 are so lacking in detail that they are no more than barely recognizable.

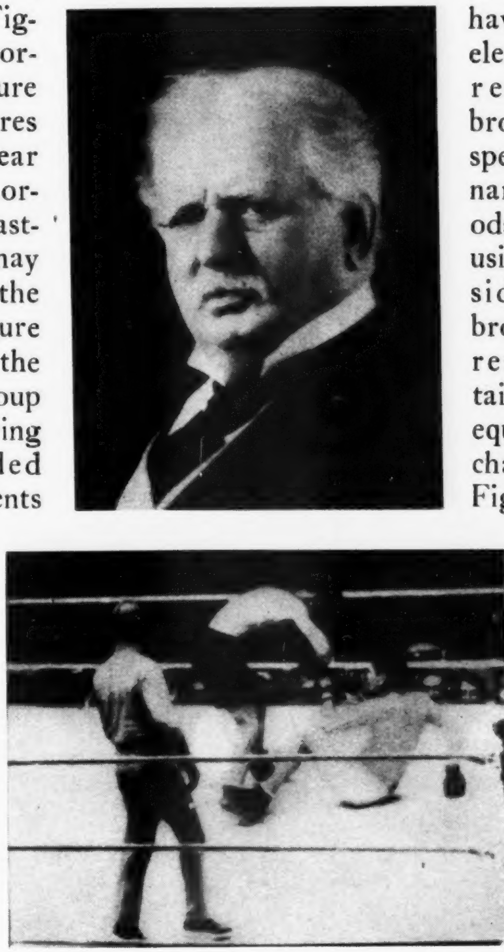


Fig. 1—*Pictures transmitted over the commercial telephotograph system containing* 250,000 *elements*

Figures 3, 4, and 5 show the same pictures as they appear when divided into greater numbers of elements than Figure 2, so as to have more detail. The pictures in Figure 3 have 1250 elements each and would require 20,000 cycles or two broadcast channels with ordinary broadcast methods. By special methods of broadcasting whereby only one of the sidebands is transmitted from the radio transmitter, the necessary frequency band could be cut in half, so that Figure 3 could be sent over a single broadcast channel. Figures 4 and 5 have 6250 and 12,500 elements, and would require 10 and 20 broadcast channels, respectively, when ordinary broadcast methods are employed. By using the special single sideband method of broadcasting, the same results could be obtained over a channel equal to five broadcast channels in the case of Figure 4 and 10 broadcast channels in the case of Figure 5.

These pictures may be compared with the images transmitted by the television apparatus demonstrated jointly by the Laboratories and the American Telephone and Telegraph Company. It should be remembered,

Fig. 2—Television images as they would appear if transmitted by usual methods over an ordinary broadcast band

Fig. 3—With two ordinary broadcast channels, 1250 elements could be transmitted. The gain over Fig. 2 is obvious

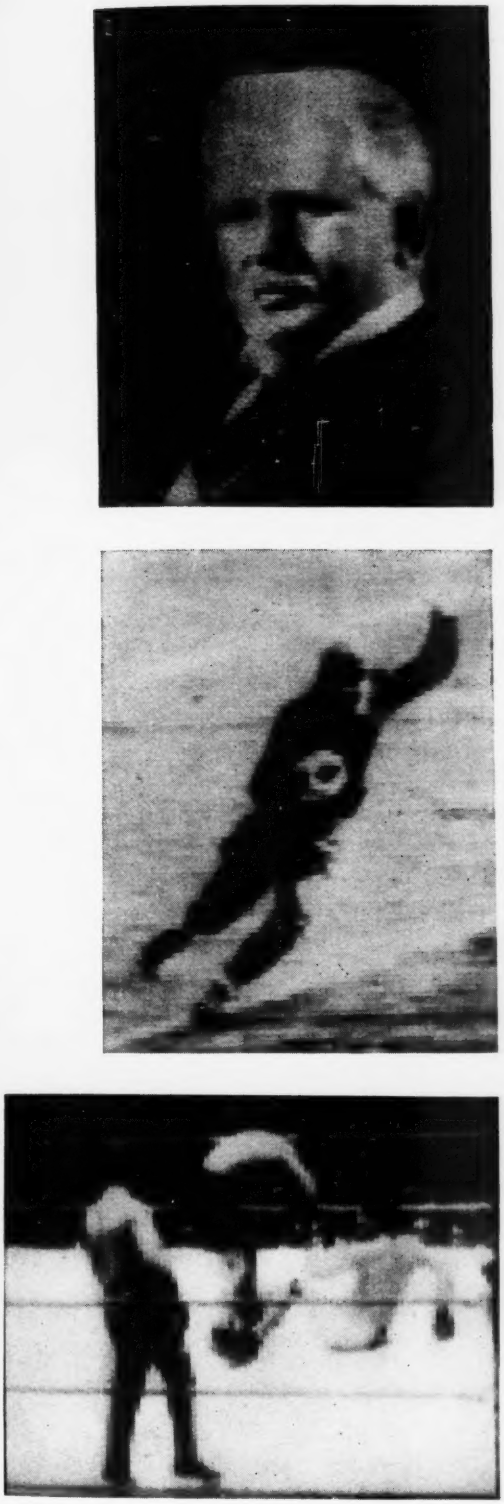


Fig. 4—By using ten ordinary broadcast channels, and transmitting 6250 elements, the appearance would be as above

Fig. 5—By employing twenty ordinary broadcast channels greater detail is gained as indicated in the group above

however, that in a moving scene, such as is viewed over the television apparatus, coarseness of detail is less objectionable than in still pictures. The apparatus demonstrated in May of 1927 used a scanning disk of 50 holes and transmitted about 2000 elements. In fineness, therefore, the image would be slightly better than that of Figure 3. With similar transmitting apparatus, the image of Figure 2 would require a disk of only 28 holes and that of Figure 3, one of 39. With the more recent two-way television apparatus, the disk has 72 holes. Some 4400 elements are transmitted, which give a picture of slightly less detail than that of Figure 4. The disk required to transmit the image of Figure 4 would have needed 88 holes, and that for the image of Figure 5, comprising about 12,500 elements, would have had 125 holes.

The illustrations were actually made by transmission as telephotographs, using apparatus in an American Telephone and Telegraph Company telephotograph station. A picture element in a telephotograph is 1/100 of an inch square, so it was only necessary to reduce the size of the pictures until they would contain the right number of elements of this size. The pictures in Figure 2, for example, were each reduced to a length of 9/32 inch. After transmission as telephotographs, the pictures were enlarged by an enlarging camera to the size shown.

It is interesting that in comparing the three pictures in any one of the illustrations with each other, the picture of the group in the prize-fight ring is about as satisfactory as the portrait or the football runner, even though the same number of picture elements is called upon to depict a larger number of objects. It appears that when several objects are being observed, some psychological factor causes one to expect and be satisfied with fewer details in each object. Another matter of interest is that in television a somewhat more pleasing effect is obtained than can be represented by still pictures, because the eye in following the movements in the television scene, is less aware of the streaks caused by dividing the image into rows of elements.

From this set of pictures, it is possible to gauge the possibilities of the transmission of television scenes as limited by the width of the frequency band transmitted. Figure 2 shows the rather crude results which are obtainable over a broadcast channel using present broadcasting methods, and the other figures show various improvements in quality which can be obtained by the use of wider frequency bands and the present methods. Just what would be called adequate detail would be a matter for individual judgment, and would have to take into account the type of service to be rendered, and the costs.

A Trial of the Radiophone in Alaska

By F. B. WOODWORTH
Special Products Development

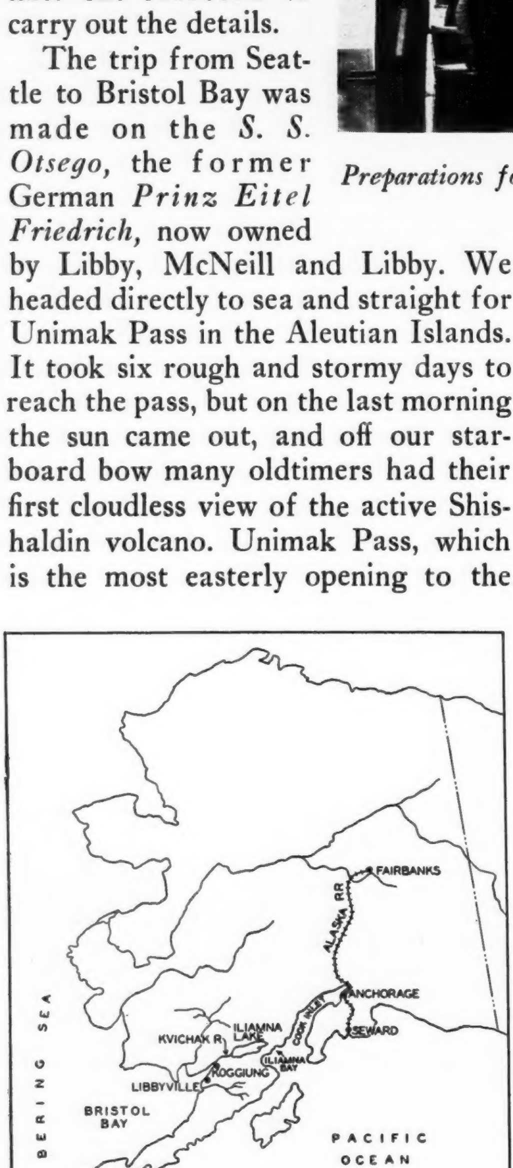
THE stories of Jack London and Rex Beach, picture Alaska for us as a land of romance and adventure arising out of man's eternal quest for gold. Yet the precious yellow metal washed from the sands of the creeks and rivers is not the chief source of the country's wealth. Far surpassing gold is the income derived from the silver hordes of salmon that each year make their way to the fresh water streams emptying into the ocean waters bordering Alaska. The salmon canning industry provides an annual return of approximately fifty millions of dollars, more than five times the amount taken out in gold.

To accumulate this wealth the canneries have adopted the most up-to-date machinery and methods. The salmon are prepared for the cans and packed by modern, automatic machinery. Mechanical conveyors carry the fish up to the cleaning and packing machines and carry away the filled cans for sealing and the pasting on of the labels. The fishing operations, moreover, are aided greatly by frequent communication between the fishing boats and the canneries, and between one cannery and another, for which radio telegraph has been used. The shallowness of the river beds at low tide, preventing reliable communication by boat, and the flat, boggy country which is unfavorable to land communication, have made radio communication a necessity. The apparatus which has been used, however, is the oldtime spark set, which owing to the interference it causes, the government refuses to license in the future. In addition, the canneries, in line with their progressive and efficient policies, have been seeking a more modern means of communication which resulted in inquiries to the Western Electric Company as to the adaptability of the radio-telephone in fulfilling their needs. Arrangements were made with Libby, McNeill and Libby to have the Lab-

oratories conduct a trial installation of a radio-telephone system in the Bristol Bay district of Alaska using equipment recently developed for aircraft communication. The author was the fortunate one selected to carry out the details.

Preparations for the fishing season. Loading gill nets into fishing boats

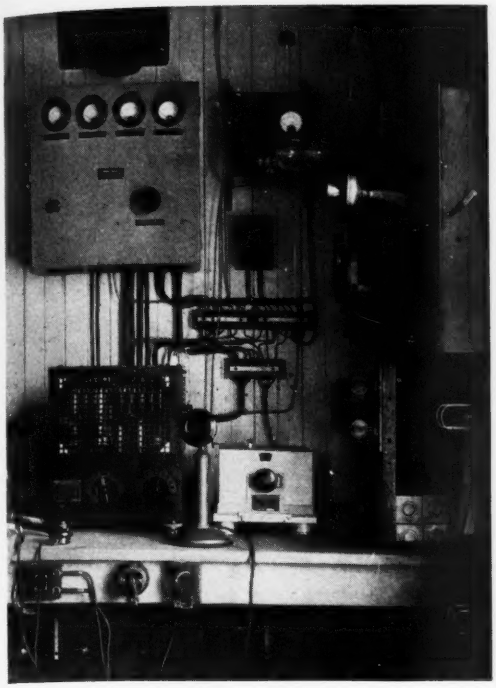
The trip from Seattle to Bristol Bay was made on the *S. S. Otsego,* the former German *Prinz Eitel Friedrich,* now owned by Libby, McNeill and Libby. We headed directly to sea and straight for Unimak Pass in the Aleutian Islands. It took six rough and stormy days to reach the pass, but on the last morning the sun came out, and off our starboard bow many oldtimers had their first cloudless view of the active Shishaldin volcano. Unimak Pass, which is the most easterly opening to the Bering Sea in the Aleutian Islands, is dangerous for navigation, especially in foggy weather. On our way through the pass we saw two Japanese steamers that had been wrecked on the rocks near the entrance.



Map of Alaska showing Bristol Bay region

Once in the Bering Sea we saw great numbers of birds, many black fish, whales and seals. This body of water is quite shallow as seas go, averaging about fifty fathoms (300 feet). For this reason the wind in stormy weather piles up the water in huge waves. A thirty-six hour trip brought us to our anchorage in Bristol Bay at the mouth of the Kvichak River. The surrounding country, low, flat terrain of mossy tundra, is not very impressive. The mud on the river banks, we found on later observation, was frozen two or three feet down. Travel is all done on water. In the numerous rivers entering into Bristol Bay there is a tidal variation of twenty feet and owing to treacherous sand bars, navigation at low tide is impossible even to the fishing boats.

The radio-telephone sets for this trial were installed on the shore at



Western Electric radio-telephone equipment installed at Libbyville

Libbyville and on the *David B*, a sturdy sixty-foot Diesel-engined craft used by Mr. A. S. Graham, General Superintendent of the Libby Canneries at Bristol Bay. The apparatus used was essentially the same as that recently developed for air-to-ground service and consisted of the Western Electric No. 8-A radio transmitter and No. 9-B radio receiver with associated apparatus. The results were fully up to expectations and successful communication was carried on between Libbyville and all points in Bristol Bay. On four occasions two-way communication at a distance of 130 miles in daylight was held with loudspeaker volume at both ends. No failures occurred during the seven weeks the equipment was in use.

The fishing and canning operations are very interesting, particularly under the advantageous conditions that I saw them. During the fishing season, which lasts but a month, the rivers are dotted with many fishing sailboats, tally scows, fish scows, and small tug boats which tow these fish scows to the canneries. Fishing is done in small sailboats with the aid of gill nets. The salmon swim into the meshes of these nets and once in, their gills prevent them from working their way out. The fishermen are paid by the number of fish they catch so that it is necessary to have tally scows near their fishing ground to count their catch. The fishermen are away from the cannery for six days at a time during all kinds of weather but owing to strict government regulations they must report to a tally scow once every twenty-four hours to deliver any fish

The David B on which tests from various points in Bristol Bay to Libbyville were made

Unloading salmon from scow into conveyor at Koggiung

they may have caught during that time.

Government regulations also provide that the fish must be canned within thirty-six hours after they have been taken from the water. Although the cleaning and handling of the fish preparatory to canning is hardly the pleasantest job in the world, the overall effect of the canning operation is one of cleanliness and care. Automatic machinery is used entirely from the moment the salmon leave the scows until the cans are packed in cases. Where formerly it required twenty or more Chinese to clean fish to supply one line of canning, a device locally known as the "Iron Chink" now does the job. The fish after being cleaned are cut in proper lengths for the can and are then forced into the can by a filler. If a can should not weigh the required pound when it comes out of the filler, two men stand ready with chunks of salmon to make up the deficiency. Next the tops are laid on and the cans are sent into an evacuating machine which exhausts the air from them and seals the tops. Between seventy and eighty cans a minute can be turned out from one of these modern canning lines. The cans are next put in trays and wheeled into huge retorts where they are cooked for ninety minutes under twelve pounds of steam pressure. After cooling they are labeled, boxed and ready for the process of distribution by which they reach the consumer.

A cannery is like a miniature city. It has its own power plant, water supply, mechanics, and is made up of numerous nationalities: Americans, who are the superintendents, foremen and machinists; Swedes and Finns, who are the fishermen; Norwegians, who are the boat captains, and Filipinos and Chinese who do the cleaning and general work.

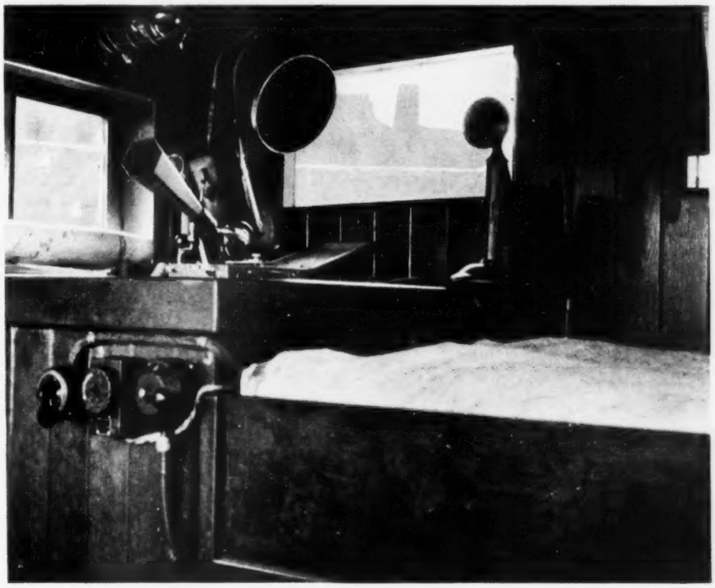
Of course, when one speaks of Alaska in summer, people always think of the sun setting as midnight approaches. It is possible to work most of the time, because of these long daylight hours, and when there are large catches of fish the cannery is running

from six o'clock in the morning until nine at night. After canning is finished for the day, all the machinery, floors and bins are washed with live steam. At about midnight the sun dips below the horizon since this section of Alaska is well below the Arctic Circle. The sunsets are wonderful displays of color and cloud effects. This year there was very little rain so we were fortunate in having, nearly every night, gorgeous spectacles of color to watch way out across Bering Sea.

For the benefit of the ardent fisherman it may be said that fishing in this country is hardly a sport, since the fish are so abundant. There are many trout of all kinds. Because they eat the salmon spawn, however, the Alaskan Government at present pays a five-cent bounty for each trout tail turned in. Salmon trout at the mouths of streams are often as close together as one's fingers. Although codfish is not a game fish, it nevertheless is good eating. During one trip between the Kvichak and Nushagak Rivers which took the boat out into deep water, two of us caught 140 codfish in three hours. It is just about a case of let your hook down and pull the fish up. In the same waters there are also halibut and flounders, but none of them can compare in eating to a nice fresh-baked king salmon.

Since everything was going smoothly and engineering services were no longer required, the writer made preparations for returning home. It would still be several weeks before the *Otsego* would start on her southward journey so he joined a party of three men from the American Can Company who had chartered a boat to go up Iliamna Lake from where they were to cross the portage to Cook Inlet. The start was made at 2:30 A.M., July 10. The first part of the trip took us up the Kvichak River and brought forcibly to our minds that the marks of modern civilization are limited to a small section of the country. We traveled for sixty miles up Kvichak River in a 30-foot gasoline launch and arrived at the lower end of Lake Iliamna at 10 P.M. On the way we passed a government weir where the salmon on the way to spawn are counted.

Lake Iliamna is a beautiful inland sea ninety miles long and forty-five miles wide, framed with mountains. It was necessary to travel the full length of it and we were fortunate in having



Control equipment for radio-telephone in pilot house in the cannery tender David B. Reception is through the loud speaker at the right of transmitter

calm weather, since the lake gets very rough during a storm. The only inhabitants in this section are gathered in the small Indian village of Iliamna at the head of the lake. After a day and night of fighting mosquitoes and withstanding the suffocating smell of a 40-horsepower gas engine, we reached this metropolis of one hundred people, mostly children — and dogs. With the exception of the schoolmaster, the only white persons were the mother and brother of "Holly" Foss, our Swedish boatman. It was quite a surprise to find the interior of their log cabin as neat and modern as a well-kept farm house in the United States. Mrs. Foss, the elderly mother, fixed us up a nice lunch and we prepared to hike the fourteen miles over the mountains to Iliamna Bay. An old "sour dough," the prospector type of inhabitant, who owned the only two horses in the region had come over from Iliamna Bay to transport our baggage across the trail. After a four-hour hike in which we encountered many ptarmigan, ducks and other small game, we arrived at the most majestic and scenic spot that I saw on the whole trip.

Iliamna Bay, with the exception of a small opening into Cook Inlet, is solidly enclosed by steep, rocky mountains about three thousand feet high. The expanses of grey rock are broken here and there by red patches of iron ore. The only permanent dwellers are three of these "sour doughs" who hunt and trap the remaining inhabitants—foxes, mink, and the big brown Kodiak bear. The Kodiak bear, one of the largest and most savage of the bruin family, is found only in this general vicinity of Alaska. During the three days that it was necessary to stay here waiting for our chartered boat, we saw fresh tracks every morning. To give an idea of the size of these animals it need only be said that the footprints measured from fourteen to eighteen inches across. As we were not provided with suitable firearms, we had no desire to go out looking for them. The author, however, spent three comfortable nights on the skin of one which had been killed during the spring. For diversion in the daytime we climbed part way up the mountains and had a still better view of this beautiful region.

On the afternoon of the third day our boat, the fifty-foot motor-ship *Discoverer* entered the bay and we embarked on one of the roughest trips which could be imagined. The airline distance from Iliamna Bay to Anchorage at the head of Cook Inlet is about 180 miles, but we probably traveled twice that far in the two nights and a day in which we pushed up the inlet. The only time a meal could be prepared was when we drew into one of the rivers on the Kenai Peninsula and stopped at a small village. Sleeping was out of the question and most of the time we spent sitting on the floor of the galley. Even the worst trip, however, has an ending, and at 7 o'clock on the morning of the second day, we tied to the dock at Anchorage. We had been a week making 300 miles which can be done in three and one-half hours by airplane. From Anchorage to Seward we traveled over the modern government railroad. Our homeward trip from Seward was made on the *S. S. Alaska* to Seattle over the beautiful southeastern inland passage.

Lamp Sockets

By S. T. CURRAN
Telephone Apparatus Development

INCANDESCENT lamps were first used for signalling purposes in telephone exchanges about 1890. Because of their compactness, the ease of restoring their indication to normal, and the positive quality of the signal which they produce, they soon largely replaced the earlier gravity-drop type of signals released electromagnetically, which were bulky and required a manual restoring operation. Since much is required of the signalling system in the modern manual switchboard, and the signalling versatility of a lamp is largely dependent on its accessories, the development of suitable lamp sockets and associated mountings has had considerable attention.

Although the sockets now used differ in minor details and in the methods by which they are mounted, all are equipped with a pair of long springs, supported and connected to wires near the back of the socket and extending parallel toward the front. When a lamp is slid between them from the front, they serve the dual purpose of holding it in position and making electrical contact with terminals on its sides. In most cases a lamp cap is held over the front end of the lamp, bearing a translucent lens which diffuses the light of the lamp so as to make it visible when viewed from in front at various angles. Usually these lenses are distinctively marked or colored to indicate the type of traffic handled by the circuit with which the signal is associated.

Lamp sockets are of two general kinds: the singly mounted, for individual lamps; and the strip, for as many as twenty lamps in a row. Singly-mounted sockets are arranged to be mounted directly on the shelves or panels which bear them. Strip sockets consist merely of contact springs, insulators, screws and bushings, and are arranged to be mounted in accessory frames which in turn are mounted in the desired locations. The sockets are ordinarily assembled on the lamp-socket mountings in the factory.

Of the singly-mounted sockets (Figure 1), two kinds, the No. 13 and No. 34, are most widely used. The former is mounted in keyshelves where it serves for cord-circuit supervisory or trunk signals. The latter, mounted in the piling blocks in jack panels, is used for master pilot signals. Sometimes these sockets are mounted in rows, by using auxiliary mountings (Figure 2), on jack panels, relay racks and the like. There are also singly-mounted

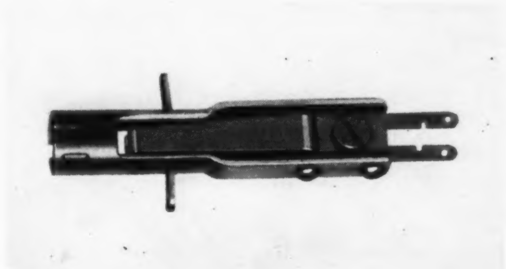


Fig. 1—A typical singly-mounted lamp socket

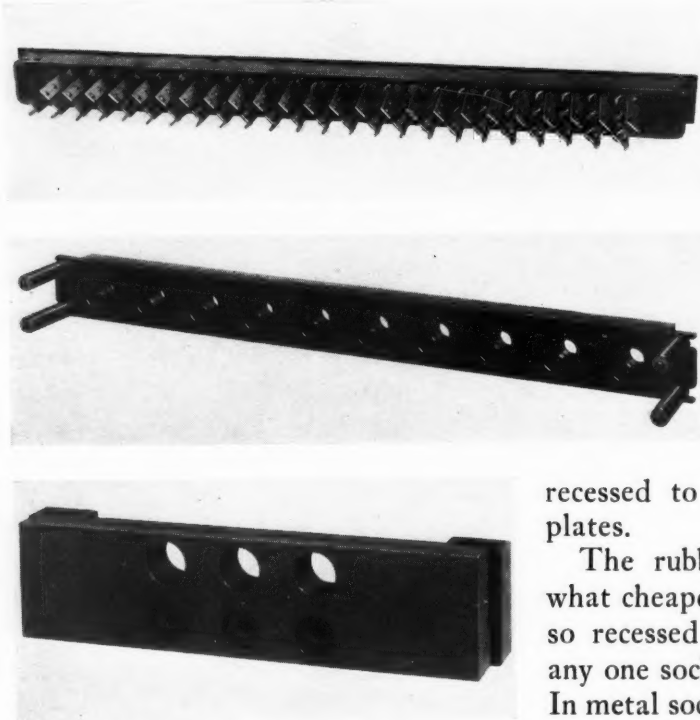


Fig. 2—Singly-mounted sockets can be used like strip sockets for certain purposes by mounting them on auxiliary strips of various types

sockets for use on mounting plates (No. 39-A) and with keys (No. 40-A and No. 44-A). A socket (No. 46-A), similar to the commercial lighting socket with a screw base, is used for holding resistance lamps on fuse and power panels.

Although there are only three types of strip sockets (No. 12, No. 30, and No. 43-A), all primarily intended for jack panels, the sockets are mounted in a variety of ways. The No. 12 socket is designed for mounting on strips of hard rubber, drilled and milled to form recesses for the lamps and springs (Figure 3). The other two are used on metal mountings, in one case with individual insulators, and in the other (Figure 4) with strip insulators as long as the mounting, with recesses for the springs. All mountings are 7/16-inch wide at the face, but they vary in length and in the spacing between sockets. Some of the faces are recessed to hold associated number plates.

The rubber mountings are somewhat cheaper than the metal, and are so recessed as to shield the light in any one socket from adjacent sockets. In metal sockets the shells of the lamp caps must extend well down over the lamps to confine their light to their proper sockets. On the other hand the advantages of the metal mountings are that the sockets can be mounted on centers as close as three-eighths inch (as in No. 92 jack panels) and that they may be used under more severe conditions of heat generated by the lamps, which tend, when a large number in a strip are burning at once, to soften and warp the rubber type of mounting.

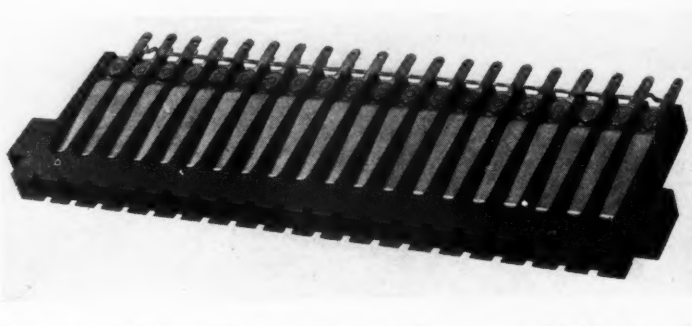


Fig. 3 — Strip sockets proper are the parts individual to the lamps. Associated with a strip-socket mounting, in this case of hard rubber, they form a row of lamp sockets

In cases where printed designation cards are associated with the lamps, it was at first customary to install designation strips to hold the cards above the lamp mountings. Later, however, a type of card was developed that is opaque except for small translucent areas spaced on centers corresponding to the lamp positions. These cards are inserted in removable designation strips having a row of holes on the same centers and held to the face of the lamp-socket mountings by spring-pronged shells fastened in several of the holes in the strip and inserted in the corresponding holes in the mounting. Thus the lamps behind the cards illuminate the translucent areas and provide signals more easily associated with the information printed on the face of the cards. In addition this arrangement saves the space formerly occupied by the independent designation strips. Two types of designation strips (No. 93-A and No. 94-A), have been designed respectively for metal (Figure 5) and for rubber mountings. On the metal mountings, in order to confine the light to the proper socket, spring-pronged shells must also be used in all lamp positions not taken care of by the shells on the designation strips. The designation strips, when in position on the socket mountings, lie flush with the faces of adjacent jacks.

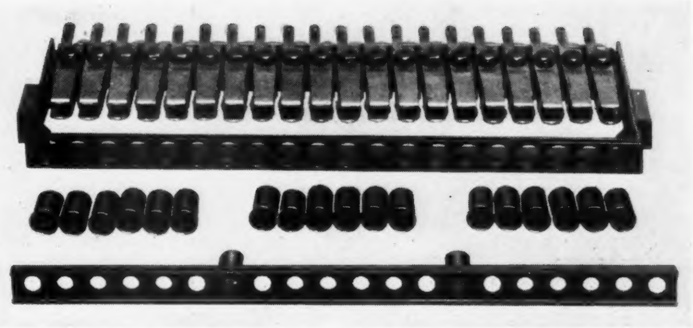


Fig. 5—Designation cards mounted above the lamp sockets in this mounting are perforated with a small hole through which the light from the lamp shines, thereby closely associating the signal with the designation

In a more recently designed metal combination, the face plate of the socket mountings and the designation strip are made in one piece. A bar 5/16-inch thick is used, in which is cut a channel with overhanging fins. These fins are cut away at the left end so that the designation card may be easily slid in place after the mounting is fastened in the jack panel. The lamp holes are large enough to permit the lamps to be removed or inserted through the face-plate when the designation card is not in place. The tip ends of the lamps lie close behind the designation cards and as the lamp holes are ¼-inch deep the face plate alone suffices to confine the light to the prpoer socket, without the use of shells or other shielding, when low voltage

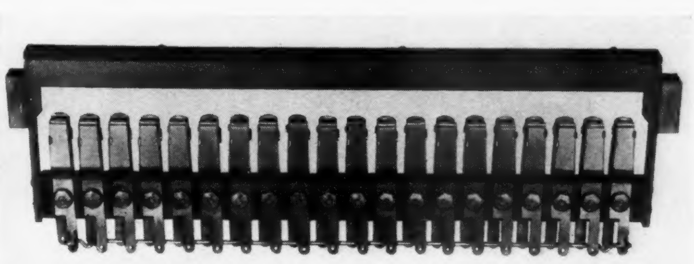


Fig. 4—Strip-socket mountings are made of metal as well as of hard rubber

tungsten filament or low illumination carbon filament lamps are employed. When other lamps are required or when this type of mounting is used adjacent to jacks on metal frames (such as the No. 92 jack) an opaque plate of phenolic material is added between the lamp-socket mounting and the jack mounting above. The plate extends eleven-sixteenths inch further back around the lamps and prevents light striking the bright metal parts of the jacks that would otherwise appear through the jack-sleeve holes as spots of light and would be confusing to an operator attempting to read the signal spots on the cards. These new mountings are used for indicating idle and busy toll lines, and occupy in the boards only half the space of the magnetic signals (No. 42-A).

This is but one example of the saving in space which the use of lamp signals has effected. Because of their compactness they have helped to make possible the development of the large multiple switchboards used today in telephone offices where thousands of lines must be within arm's reach of each operator.

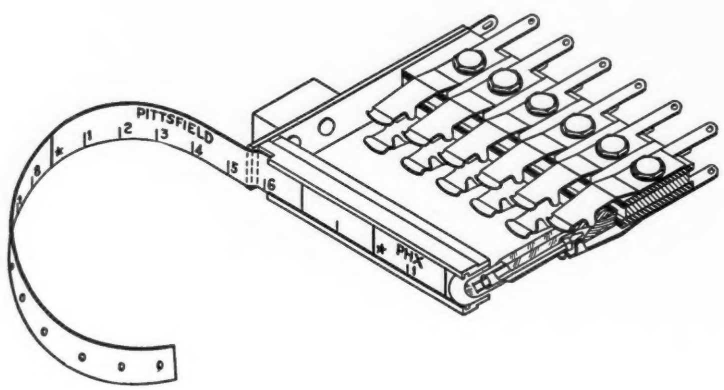
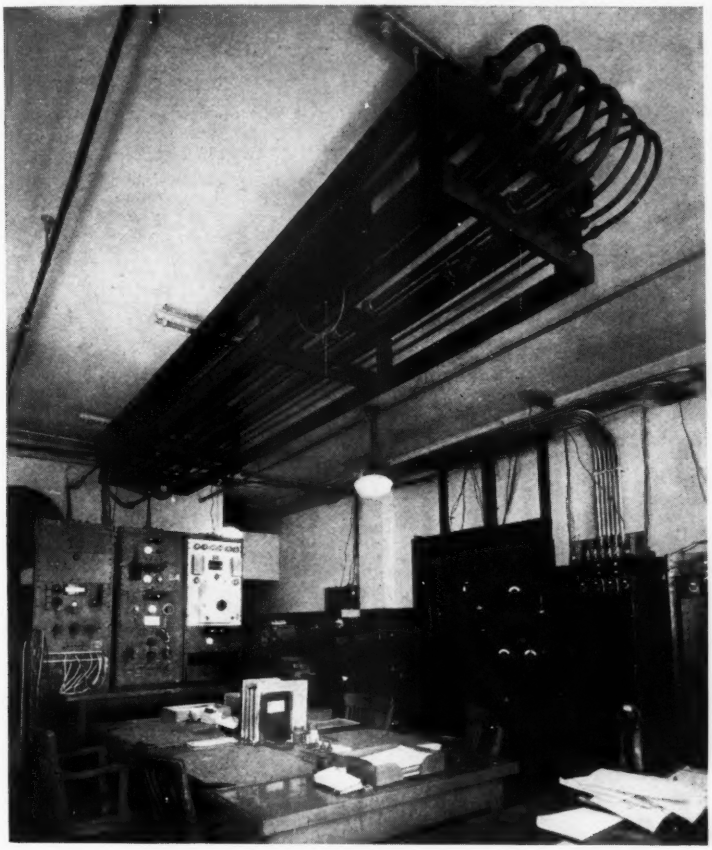


Fig. 6—Recent strip sockets incorporate their associated designation strips



More Phonograph Records Illustrating Distortion

By W. B. SNOW
Acoustical Research

TELEPHONE engineers long ago undertook as one of their fundamental problems the study of speech characteristics. They were interested in its frequencies and amplitudes and the preservation as far as possible of its tone qualities when transmitted over telephone circuits. With the advent of radio broadcasting, music became a collateral study.

Investigations of the physical nature of musical sounds and speech involved the effect on listeners of such factors as loudness and reproduction of varying ranges of pitch. Attenuators and amplifiers permit volume control within wide limits; and filter networks enable pitch ranges to be blotted out at will. Filters are of much aid in illustrating distortion in speech and music, since through cutting off frequencies most of the common distortion effects may be reproduced. Visitors to our Laboratories usually view with great interest the experiments of frequency analysis made possible through filter networks.

Largely owing to this interest a

number of phonograph records for demonstration and lecture use were made about four years ago. Through the elimination of various regions of frequency, the relationship of naturalness, sound intensity, intelligibility in the case of speech, and brilliance in music, to frequency range was clearly pointed out. Examples of speech and

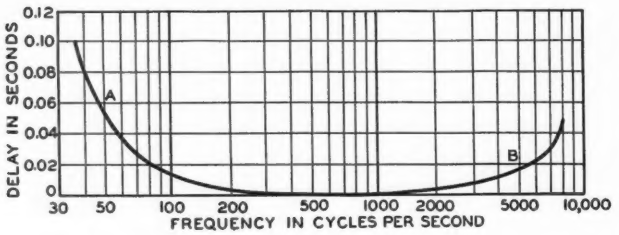


Fig. 1—Delay characteristics of a program transmission circuit

music with first the lower, and then the upper frequencies suppressed were demonstrated, as well as the distortion resulting from cutting off both ends of the frequency range. Another type of distortion demonstrated was that caused by an amplifier carrying an overload. The records were cut by the electrical method developed in these Laboratories.

These earlier records* have been supplemented by new examples of acoustical phenomena produced by apparatus developed since the first records were made. Intensity change and the magnitude and practical value of the decibel is demonstrated by the first of these new records, known as Bell Laboratories Record 3-A. To the ear, difference in intensity is perceived on a logarithmic basis and the minimum loudness change ordinarily perceptible is the logarithmic unit termed the decibel. In demonstrating the decibel, which corresponds to a 20 percent change, a section of orchestral music is played; then sections in which the intensity is successively reduced 1, 3, 5, 10, 20 and 30 decibels. It is difficult to tell the difference when the reduction is 1 decibel corresponding to an energy ratio of 0.8; nor is the difference striking for the 3 decibel reduction when the energy ratio is 0.5. With the reduction of 30 decibels, ratio 0.001, the music still remains audible; a further reduction of 30 decibels, corresponding to an energy ratio of .000001 would be required to render it inaudible in the absence of all other noise. On the reverse side, 3-B, samples of speech are given identical treatment.

At the time the first records were made, the electrical recording methods developed in these Laboratories had recently been adopted by the Victor Talking Machine Company, and J. P. Maxfield, who had directed the development here had gone to that Company to supervise those further developments which commercial use might indicate. Accordingly the Victor studios were selected to make the demonstration records and filters from the Laboratories were taken to Camden and operated under the direction of A. C. Keller.

The contribution of harmonic content to tone quality of musical instruments is illustrated by the fourth record of the series, which was planned by R. W. King and P. C. Jones and made in the Laboratories. Comparison is made of sustained tones of 256 cycles, or middle C, produced by the piano, 'cello and French horn. First, all harmonics are suppressed; then, all but the first and second, first to fourth, first to ninth, first to seventeenth. In the first instance, with only the funda-

*Bell Laboratories Record, *February,* 1927.

mental reproduced, it is impossible to distinguish between the instruments. With fundamental and first overtone the beginnings of distinction are present; in the other instances the sounds are easily distinguishable although still appreciably distorted from their true quality. The 'cello requires the widest frequency range for correct reproduction, the piano the next widest, and the French horn the narrowest.

The other side of this record reverses the procedure and eliminates successively the fundamental, fundamental and harmonics up to the third, fundamental and harmonics up to the sixth, and fundamental and harmonics up to the tenth. The quality of all three instruments is markedly affected by removal of the fundamental. Even with harmonics up to six removed, however, the instruments are recognizable, although the difference in harmonic content is very noticeable. Here the 'cello is reproduced better than the piano or French horn, which are shown to have fewer high harmonics by the previous experiments with low-pass filters.

Record No. 5 is similar to No. 4 in technique but a different effect is emphasized. Sustained tones of a male voice, an organ pipe, and a clarinet were passed through high-pass filters to remove successively the fundamental and the fundamental plus various harmonics. Although great quality differences result, the pitch of the tones remains the same. The ear apparently perceives pitch not only from the fundamental frequency itself but also from the spacing of the harmonic frequencies.

The next record of the series provides illustration of phase distortion. When a band of frequencies is sent over a circuit which transmits the different frequencies with different velocities, the frequencies starting together — in phase — arrive at the far end at different times — out of phase. Experience has shown that a considerable amount of this type of distortion can occur without being perceptible to the ear. On long cable circuits, however, both high and low frequencies are subject to a delay so that with wider frequency ranges and for the present increased length of telephone cable circuits, phase distortion creates a very important problem for the telephone engineer.

Ordinarily the distortion will be of the form shown by curves A and B in Figure 1, where the relative delay is plotted in seconds rather than in terms of electrical degrees of phase shift. The high-frequency delay produces an effect often called by the descriptive name "birdies," because the higher

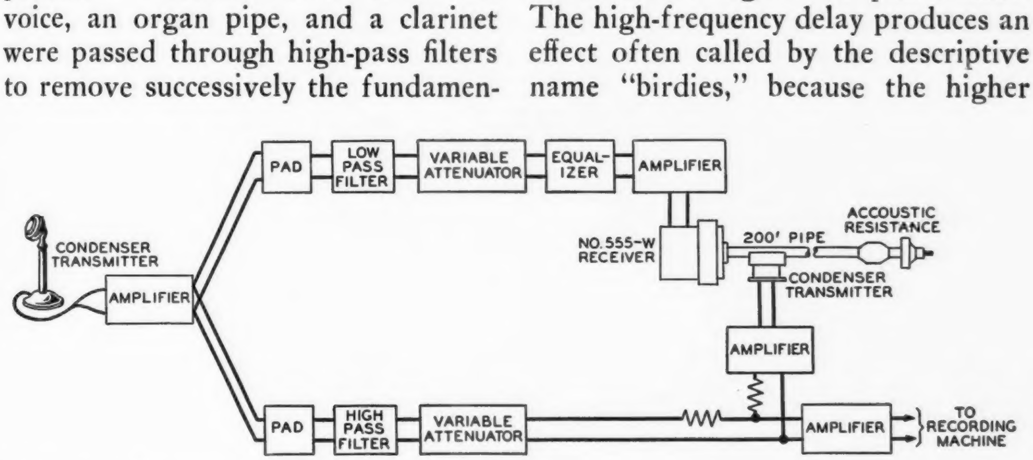


Fig. 2—Diagram of acoustic delay circuit designed to measure effect of delay on articulation

frequencies arriving late add little "tweets" and whistles to the transmitted sounds. They are particularly noticeable on transmitted noises such as clicks or knocking sounds which contain many high frequencies. The low-frequency delay creates the impression of echoes by producing extra thuds after all low-frequency sounds.

The phase distortion illustrated by this record is an exaggerated example, made with apparatus designed expressly to measure the effect of delay upon articulation. The apparatus made use of the fact that sound travels through air at a velocity very small compared to the velocity of propagation of an electrical impulse through a resistance network. By combining air and electrical transmission it is possible to delay one part of a sound considerably with relation to another.

The circuit accomplishing this is shown in Figure 2. Speech, picked up by a condenser transmitter and amplified, is fed to two branches. The low frequencies are passed by the low-pass filter into a No. 555-W receiver unit which converts them into sound to be transmitted down a long pipe terminated by an acoustic resistance to reduce reflections. The sound is picked up by a condenser transmitter which can be placed at several points along the pipe corresponding to several delays. A high-pass filter transmits the high frequencies to an attenuation network so set that the loss through both branches is the same. Then the outputs of the two branches are combined and amplified for the recording machine. The electrical transmission is almost instantaneous, so that the time of the air transmission down the length of the pipe may be taken, without appreciable error, as the delay introduced. A photograph of the apparatus appears as the headpiece. The filters shown are the same ones used in making most of the other records.

The record of phase distortion starts with some explanatory remarks which describe the effects to be shown. Then the speech transmitted through the pipe is reproduced, that is, speech below 1000 cycles which was the dividing line for this experiment. Next the frequencies lying above 1000 transmitted through the electrical branch are heard. When the two are reproduced together the lower frequency range is found to be delayed .1 second behind the upper. It sounds like two people talking at once and the words, transmitted over the two ranges, are difficult to interpret. The next two bands show respectively the effect of .07 and .035 seconds delay. The latter, while sounding peculiar, is almost as easily understood as if no delay were present. Delays of the order of .01 second are rarely noticed.

The next record of the series, No. 7, contains a description and demonstration of the method of measuring noise employed by Messrs. Steinberg and Galt in a recent survey of street noises for the New York Noise Abatement Commission and in room and office noise measurements for the American Telephone and Telegraph Company. The method is applicable to the measurement of noises reasonably continuous in character. The output of an electrical phonograph is fed through a variable attenuator to a receiver equipped with a slotted cap that admits both extraneous noise and the tone from the phonograph. The observer, with the receiver to his ear, adjusts the attenuator until the tone is just audible in the presence of the noise. From the previous calibration of the instrument in a sound-proof

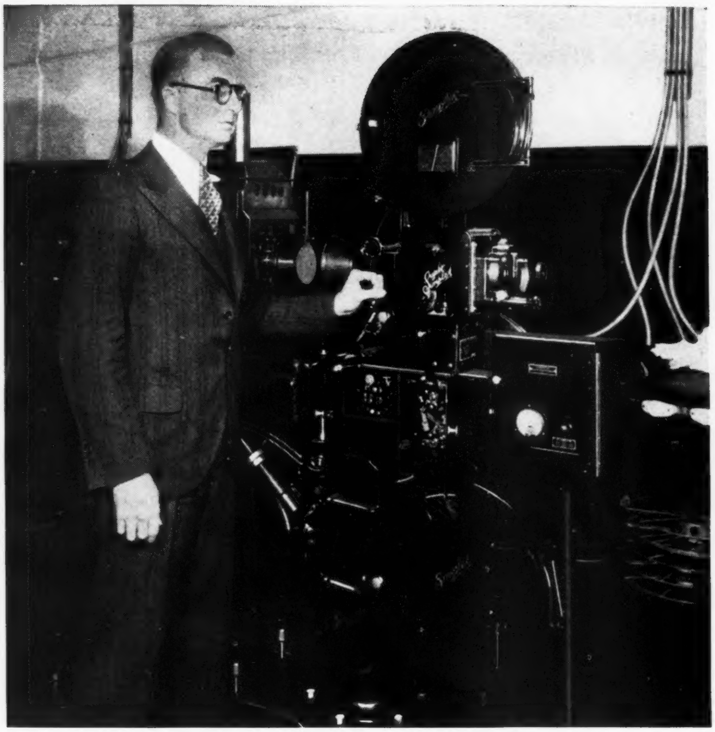
booth the setting of the attenuator to make the tone just audible when no noise is present is known, and the difference between that setting and the setting in the presence of the noise is the masking of the noise which is a measure of its intensity. Three warble tones are used, varying through 250 to 750, 750 to 1500, and 1500 to 5600 cycles respectively, to give a rough frequency analysis of the noise.

The record describes this apparatus as well as the units used in noise measurement and then exhibits a representative measurement of street noise. As a sample of recorded street noise is heard, the middle band warble tone is increased in intensity until it is just audible above the noise. Then as a demonstration of how much the noise is masking the warble tone, the noise is cut off leaving the warble tone unchanged and the apparent increase in loudness of the tone is startling. It is explained on the record that since the setting of the attenuator had to be increased 60 decibels over the quiet room setting to render the warble tone just audible in the presence of the noise, the noise is taken as having a masking of 60 decibels in this frequency range 750 to 1500 cycles.

The latest record of the series demonstrates acoustic reflections, or echoes, and their effect on speech and music. The methods used are similar to those employed by H. D. Arnold in the talk which he gave at the inaugural meeting of the Acoustical Society of America. The effects produced give one an idea of the inherent problems in the architecture of an auditorium to prevent the distortion of speech and music by reflected sounds.

One hears first on the record, No. 8, an unattenuated echo from a wall 35 feet distant. There is a flutter to the speech, although its intelligibility is but slightly impaired. In the next demonstration, when the unattenuated echo proceeds from a surface 100 feet away, it sounds as though two persons were talking. The shorter syllables are heard twice in succession. Actual echoes, however, are attenuated by distance and by absorption at the reflecting surface, and the next portion of the record illustrates the changing effect of echo as it is gradually reduced in intensity. Following this, echoes are presented from four walls, 35 to 100 feet away, attenuated about the same amount as in a small auditorium. The speech is then so jumbled as to be almost unintelligible. When, for comparison, a musical passage is given identical treatment, the effect is not so pronounced, nor is it displeasing because the tones of a musical note are ordinarily sustained for much longer periods than those of speech. As the record explains, any acoustic reflection produces a distortion of the original sounds, but often a certain amount of reflection is desired to add sonority or to increase the loudness of a sound. As a consequence the provision of just the right amount of echo in an auditorium is of major importance.

Other records are in prospect to add to this series which has been found to have considerable interest to college laboratories of physics and psychology to which it is distributed.



New Sound Reproducing Equipment for Theatres

By G. PULLER
Special Products Development

FROM the introduction of sound pictures to October 1, 1930, Western Electric sound-reproducing equipment has been installed in nearly seven thousand theatres, two-thirds of them in the United States and the rest in other parts of the globe. Most of these systems were for the larger theatres where quality of reproduction was paramount, and where the cost of the equipment was of secondary importance compared to the possibility of augmented profits created by the popular demand for sound pictures. It soon became apparent however, that many of the smaller theatres, although realizing the advantage of sound reproduction, could not, in view of their restricted seating capacity and therefore limited financial returns, justify the cost of the Western Electric large-theatre systems.*

To meet the demands of theatres of this type, a small-theatre reproducer has recently been developed by the Laboratories. The new equipment, introduced to the field in July, 1930, makes available to theatres with a seating capacity of twelve hundred or less, a sound-reproducing system of a quality comparable to that of the large-theatre system. To make a

* BELL LABORATORIES RECORD, *Sept.*, 1929.

lower cost possible, however, certain features embodied in the large-theatre system have been omitted. In addition some of the apparatus, such as the amplifying equipment, has been simplified.

Complete equipment for a theatre includes two of the new sound film reproducing attachments mounted on the projector pedestals. The projector may be one of the various Simplex types, or, by the use of suitable adapters, of other well-known makes. In separate units mounted directly in front of each projector are preliminary two-stage amplifiers, the outputs of which are carried to a control cabinet usually mounted on the front wall of the projector booth. From this cabinet the sound circuit extends through the main amplifiers to the loud speakers. A diagrammatic representation of the complete system is shown in Figure 1.

The film reproducing attachment proper comprises a lamp compartment, a film compartment, and a photoelectric-cell compartment. The lamp compartment, although differing in construction, contains in general the same equipment as that of the larger system. An exciting lamp furnishes a light source of high intensity which is projected by an optical system as a concentrated beam of light a thousandth of an inch wide on the sound track of the film. Since the lamp must be located in exact relation to the optical system, it is mounted on a special bracket which permits adjustment in any direction, and is locked in position. The lamp and bracket is replaceable as a unit without disturbing the adjustment. This permits spare lamps and brackets to be adjusted and held ready for use should replacement become necessary during the showing of a picture.

In the film compartment the initial step in reproduction takes place since here light from the exciting lamp is focussed on the sound track of the film and the modulated light beam passes on to the photoelectric cell. The film is pulled across the light beam at a uniform speed by the sound sprocket mounted in the upper part of the compartment. To prevent any irregular movement of the film past the light beam, loops of film are left both in the picture projector above the film compartment, and immediately below the sound sprocket. The upper loop prevents any irregularities of motion of the film as it comes from the picture projector from being transmitted to the film compartment, and the lower loop prevents any unevenness of pull due to the take-up mechanism in the film magazine below. A second sprocket maintains this loop by acting

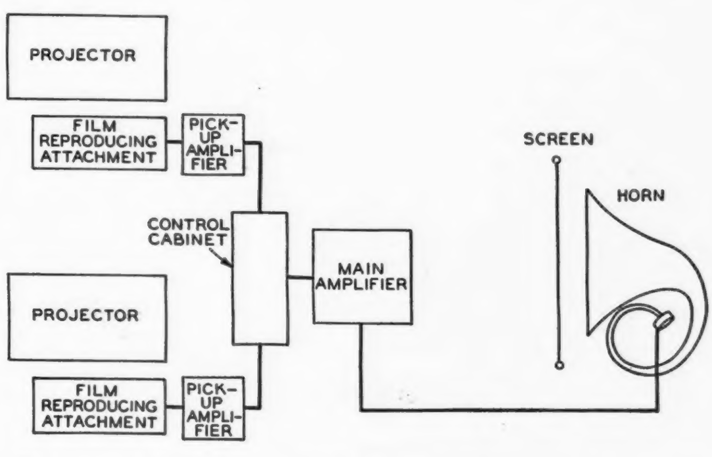


Fig. 1—Schematic arrangement of apparatus for small-theatre reproducer

as a holdback to the pull from the take-up in the lower compartment.

The shafts on which these two sprockets are mounted are inter-connected by a train of three gears, one of which drives the picture projector mechanism. A 1/6 horsepower single-phase induction motor, mounted on a bracket supported from the projector pedestal, supplies the motive power to operate the machine. On the sound sprocket shaft is a large pulley which is driven from the motor-pulley through a pair of woven fabric belts. Two independently acting idler pulleys provide constant tension for the driving belts under all conditions. Not only is this type of drive quiet and free from vibration but it provides a very efficient filtering action which assures uniform rotation of the sound sprocket: an essential to high-quality sound reproduction.

To guard further against the transmission of any disturbances to the sound sprocket, the driving gear is mounted so as to float on the shaft of the sound sprocket and is coupled to it through a cushioned yoke. Guards are available when desired for covering the flywheel-pulley, and a brake may also be provided where it is desired to stop the machine in a shorter period than would normally be required. The flywheel-pulley and double-belt drive are shown on Figure 2.

The photoelectric-cell compartment is next to the film compartment and houses only the photoelectric cell. These three major elements of the sound-film reproducer are shown in Figure 3. The photoelectric cell, al-

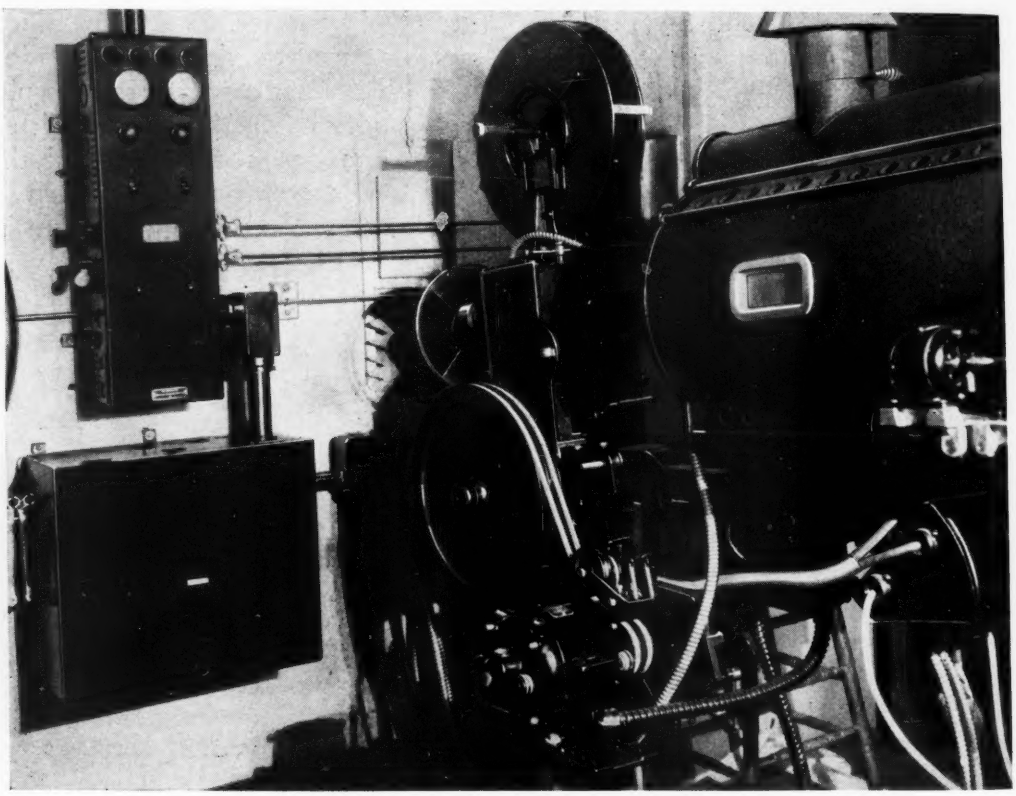


Fig. 2—The drive side of the small-theatre projector in an actual operating booth showing the control cabinet mounted on the front wall

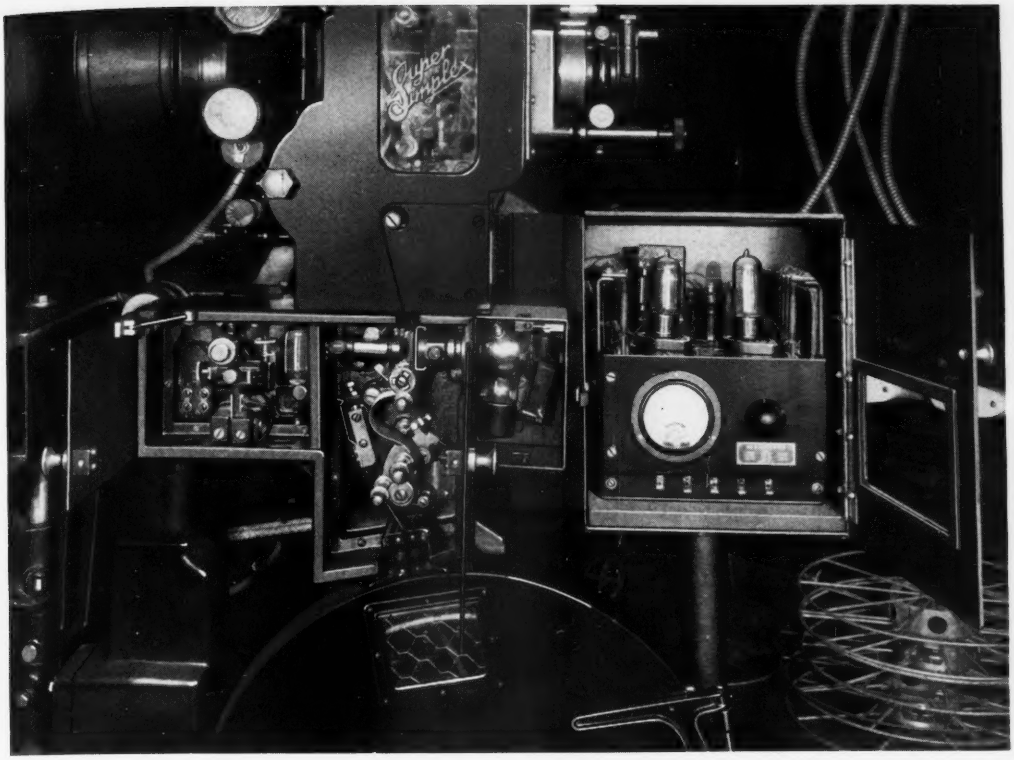


Fig. 3—Close-up of lamp, film and photoelectric cell compartments with the preliminary two-stage amplifier supported on a separate pedestal in front of the machine

though only slightly susceptible to microphonic response, is mounted on a cushioned support to eliminate any microphonic noise that might be picked up at this point.

The preliminary amplifier raises the voice-frequency output of the photoelectric cell to a level suitable for further amplification by the main amplifiers. It comprises a two-stage transformer-coupled amplifier similar to that used with the earlier machine, but is mounted in a self-supporting housing entirely separated from the projector proper. This reduces the possibility of vibrations being directly transmitted from the projector to the amplifier, and to minimize further the pick-up of vibration the amplifier is suspended by a set of coiled springs in a cradle mounted on a rubber pad.

The switch and control cabinet, shown in Figure 2, serves for switching the sound circuit from one machine to the other, and for regulating the overall volume output of the system. It also contains green and red signal lights to indicate the circuits in use. From this cabinet the circuits are led to the master amplifier and thence to the loud-speaking telephone located back of the screen. These units may be of any of the usual types as dictated by the power and installation requirements.

This new sound reproducing equipment is of rugged construction and simple to operate, while at the same time it is capable of high-quality reproduction. All parts subject to wear are interchangeable and easily replaceable. Accessibility of the essential parts, simplicity of equipment, and easy threading of the film have all

been particularly stressed in the design.

In accordance with our usual practice in the case of newly designed equipment, an accelerated life test is being made upon this reproducer. This test consists of repeated cycles of starting and stopping which imposes the most severe stresses upon the mechanism. The duration of the test thus far is equivalent, with a substantial margin, to six years' service in a theatre operating nine hours a day. Very satisfactory results have been obtained and the test is being continued.

Report of Employees' Benefit Committee

Payments under the Employees' Benefit Plan, for all purposes, amounted to $117,037 during 1930. There were no serious accidents during the year. In proportion to the number of employees there were fewer accidents and fewer days lost on account of accidents in 1930 than in any previous year of the Laboratories. In sickness, too, a low record was reached, since, in proportion to those eligible for sickness benefits, there were 12% fewer cases and 18% fewer days lost in 1930 than in 1927 which was the best previous year.

A special feature of this year's activities of the Committee was the bridging of breaks in the Bell System service of 277 members of the Laboratories who had completed 10 years of continuous service or whose absences had been for educational reasons. An average of 2½ years of additional service was credited to each of these members in amounts ranging from 1 month to 18 years.

Members of the Employees' Benefit Committee are H. D. Arnold, Chairman; A. F. Dixon, J. W. Farrell, R. L. Jones, J. E. Moravec, J. G. Roberts and G. B. Thomas. A. F. Weber is Secretary of the Committee.

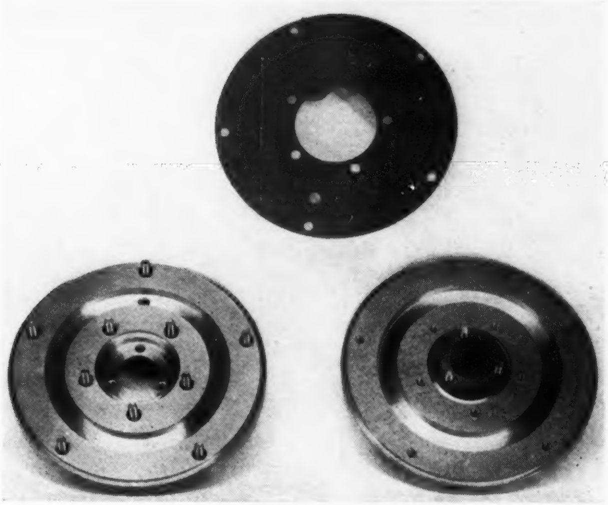
A report of payments made under the Plan, during 1930, as prescribed in paragraph 30 of Section 8 of the Plan for Employees' Pensions, Disability Benefits and Death Benefits follows:

Pensions	$ 8,940.85
Accident Disability and Death Payments	8,544.22
Sickness Disability Payments	91,502.02
Sickness Death Payments	8,050.00
Total	$117,037.09

A. F. Weber, *Secretary*
Employees' Benefit Committee.

The above statement of payments audited and found correct.

E. J. Santry,
General Auditor.



Washouts

By W. L. HEARD
Equipment Development

BEFORE newly developed equipment has reached a stage of production that allows it to be photographed, it is possible to construct photographs synthetically by a method already described in the Record.* Such photographs are entirely satisfactory for a great many purposes. There are also occasions when the reverse of this process is necessary. Occasionally photographs may be on hand of equipment for which there are no drawings. To accomplish this converse process, the Systems Drafting Department has developed a method of translating photographs into finished drawings in three dimensions. The process is simple and inexpensive and often is the most economical way

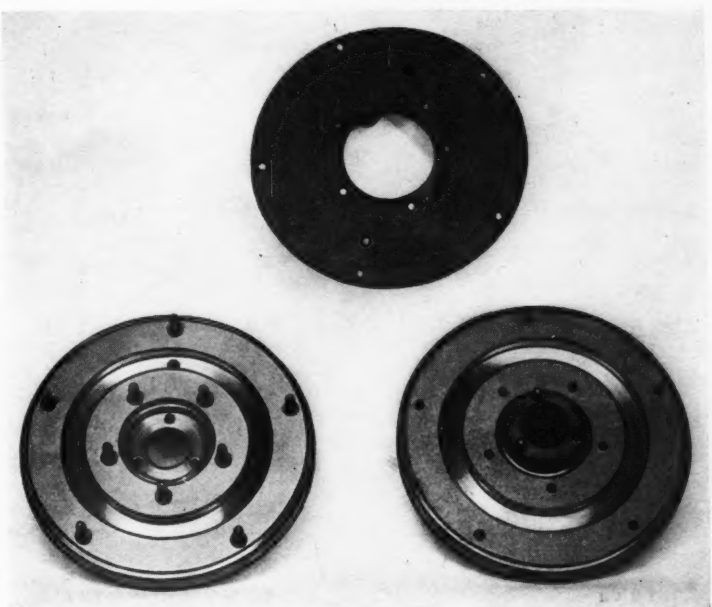


Fig. 1—On the final washed drawing additional details, dimensions, and shadings are added

* BELL LABORATORIES RECORD, *April*, 1930, *p.* 379.

of making perspective drawings of various types of equipment.

The method may be employed for the production of drawings of any size, and changes can be made during the process as desired. The photograph that is to form the basis of the perspective drawing—the Interrupter Disc at the head of this article may serve for illustration — is first enlarged to several times its original size. Either a photostat or an enlarged photograph will serve but it should be the size of the desired perspective drawing. No great amount of detail is necessary since the perspective outline is the essential part.

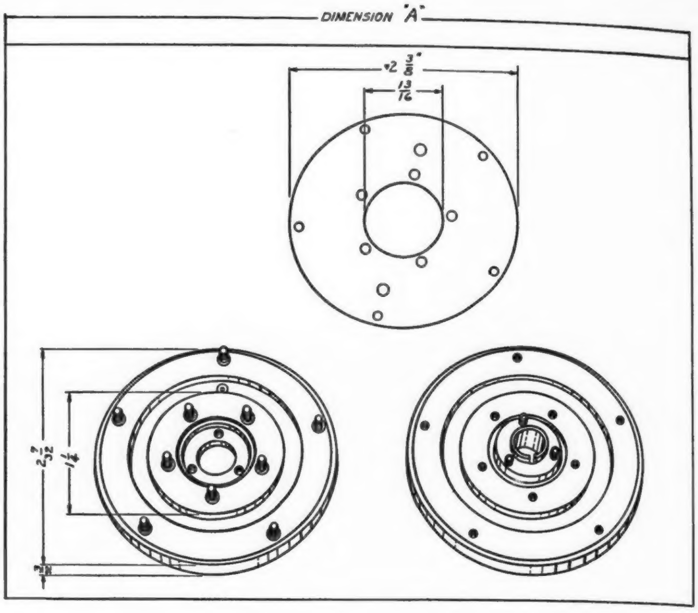


Fig. 2.—An inked outline is drawn on the photostatic enlargement

On this reproduction the draftsman inks in the perspective outline, and may add any details or dimensions that are required, or shading lines to bring the surfaces into relief. At this stage the drawing is a composite of a photostat and a perspective drawing as shown in Figure 1. To convert this to a black and white drawing it is given a bath in a bleaching solution which fades out all but the ink.

The bleaching bath is formed from three solutions mixed separately: one of potassium iodide, one of iodine, and one of potassium cyanide. Careful mixing and handling is required for satisfactory results. The wash produces a clear black and white drawing — as shown in Figure 2 — which when dried may be used as would any projection drawing.

Any shading, dimensions, or changes which were not put on the photostat may now be added, and, of course, changes may be made at any time thereafter. With more complicated drawings than those shown in the illustrations, the savings in producing perspective drawings by this method may be considerable.

Saying It With Tones

By P. HUSTA
Local Systems Development

IN REDUCING the operating effort required to establish a talking connection between two telephone subscribers, signaling tones play an important part as traffic aids. They take the place of part of the verbal information formerly passed from operator to operator and from operator to subscriber. They serve also to convey certain other important information to operators and to the maintenance force in a central office.

It was the practice, for example, before the audible ringing system was developed, for the manual-system's "A" operator to inform a calling subscriber, when necessary, that she was ringing the bell of the desired line. Today, the general public has been educated to recognize certain signaling tones as indications of the progress of a call from its start to its completion. For the ordinary classes of telephone calls, the calling subscriber listens for these signaling tones to determine either that the called party's line is being rung or that it is busy.

With the adoption of the dial system, informative signaling tones become of prime importance due to the absence of the operator. The familiar "Number please" has been replaced by the dial tone, a continuous tone of low pitch which informs the calling subscriber that the central office equipment is ready to receive the call and that he may commence to dial. The line-busy and audible-ringing signal are required of course, and in addition a signal indicating a busy or trouble condition of the mechanical apparatus is used. In the dial system of the panel type this signal is known as the trunks-busy tone, and sounds like the busy-line signal. In the step-by-step system the all-paths-busy, and the vacant-level tone, known as the no-such-number signal, also have the same pitch as the line-busy tone, and perform similiar functions. These signals inform the subscriber to dial again so that the call may be routed through a different channel.

These illustrations indicate the more commonly known uses to which signaling tones are applied for conveying information or instruction to operators and subscribers. Signals to toll operators indicating the collection or return of the coin on coin box calls; dial-testing tone, a signal to the dial test man at the subscriber's station indicating the condition of the dial adjustment; trouble tone, which is connected to the sleeve of manual subscribers' lines that are out of order; permanent-signal tone, which assists the test man in a dial office to locate a subscriber's line which is out of order; and howler tone, a signal intended to attract attention of a subscriber if he inadvertently has left the receiver off the hook, are other common applications of signaling tones.

It might appear from this long list that it is necessary to have available

in a central office quite a number of different and distinctive tones for the various applications. While this is true as a matter of enumeration, the tones, with the exception of the audible ringing-signal tone, fall into two major classifications — low tone and high tone. As the name implies, low tone is lower in pitch than high tone, the low tone fundamental frequency being approximately 153 cycles per second while the high tone fundamental frequency is approximately 460 cycles per second. Both of these tones are produced by interrupting the central office battery by means of rotary type interrupters through suitable repeating coils. The audible ringing signal on the other hand is obtained from the harmonics in the ringing current. It is generally of the order of 400 to 600 cycles per second depending on the ringing machine. The rippling character of this tone is due to a modulation effect produced by the twenty-cycle fundamental of the ringing current.

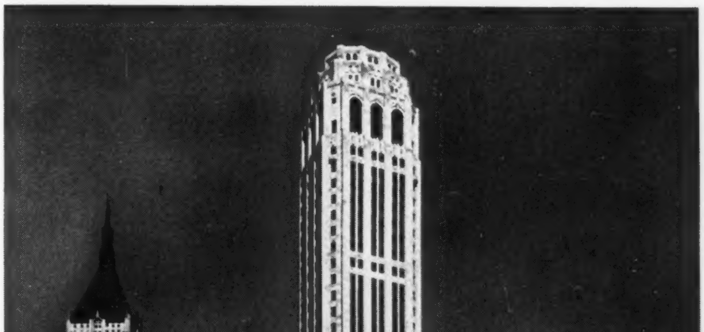
To secure distinction between various tones in the same general classification, the tones as applied to the circuits are either continuous or interrupted in different manners. The dial tone for example is a steady or continuous low tone. Busy tone is also low tone but it is interrupted at the rate of sixty interruptions per minute. The trouble tone used in manual-system central offices, however, is also a continuous low tone, but since it is connected to the sleeves of lines out of order, only an operator or a maintenance man can receive it. There can be no confusion of this tone with the dial tone since the one is used with the manual system while the other is employed only with the dial system. Thus not only is there a differentiation by the division into continuous or interrupted tones, but also both by the circuit over which the tone is sent, and by the person by which it is received.

Signaling tones are thus employed advantageously to indicate various conditions encountered in the completion of a call. By reducing operating effort they have enabled operators to handle more calls per hour, and, because of the prompt and accurate information they convey, are a valuable aid to the service in general.

NEWS AND PICTURES

of the

MONTH



The new City Bank Farmers Trust building, in which communication equipment of unusual interest has been installed

General News Items

Discuss Color Measurement

In a paper delivered at the joint meeting of Optical Society of America and American Physical Society, Herbert E. Ives and E. F. Kingsbury declared that the use of the photoelectric cell as a substitute for the human eye in color evaluation still falls considerably short of attainment. There are three general methods existing for the measurement of color by visual means, namely, trichromatic matching; measurement by hue, luminosity and purity matching; and spectro-photometric analysis. Of these, the first and third only are susceptible to reduction by physical processes. In the measurement of color, moreover, the ideal instrument would be capable not only of giving precise discrimination of intensity values, but also would indicate these values upon a scale.

Despite the remarkable advances in the development of the photoelectric cell, the account declared, the device is not yet capable of fulfilling this ideal. Future use of physical methods of color measurement, it was pointed out in the paper, is dependent on development of general colorimetric methods; on the choice of conventions as to measuring conditions; and a realization that color alone does not completely describe many of the most important characteristics of colored surfaces.

Theory of Fatigue Failure Proposed in A.I.M.M.E. Lecture

Hardened steel of the type used for many parts of an automobile motor may be honeycombed with a network of very fine cracks, F. F. Lucas declared in the Howe Memorial Lecture before the American Institute of Mining and Metallurgical Engineers on February 18. During the last ten years, Mr. Lucas' contributions to the art of metallography — which include bringing the ultra-violet microscope to a high state of perfection — have greatly extended the possible limits of useful magnification in dealing with metal samples under the microscope. It is this extension of the limits of magnification which made possible Mr. Lucas' discovery of these minute cracks in steel.

In spite of the very small size of these cracks — only a few hundred thousandths of an inch across — it is believed that they may be the starting point of many of the so-called "fatigue failures" met in automobile crankshafts and axles under conditions of great cyclic stress. These cracks generally occur along the borders of the martensite crystals which are formed in the steel during one stage of the hardening and tempering processes. It therefore seems probable, Mr. Lucas asserted, that they are formed as the result of an extremely minute shrinking of the steel as it passes from one crystal stage to another during the tempering treatment.

Stress tends to widen and extend the cracks until finally the steel gives way. Fatigue failures have generally been guarded against by using more steel than would otherwise be required. In

fact it is believed that further investigations will show, not why steel is as strong as it is, but why it is as weak as it is. If it should prove possible to develop a heat treatment which will harden steel as well as the methods now in use without forming these tiny cracks, the strength of the steel will be greatly increased and it will be possible to use much less steel than at present.

Daughter of Dr. Bell a Visitor to Laboratories

Mrs. Gilbert Grosvenor, daughter of Alexander Graham Bell, and her daughter and son-in-law, Mr. and Mrs. Paxton Blair, were guests of the Laboratories on February 24. They were received by Mr. Charlesworth and conducted through several of the laboratories by S. P. Grace and G. F. Fowler.

The visitors spent considerable time in the Historical Museum in viewing some of early developments of Alexander Graham Bell. Mrs. Grosvenor recounted to Curator W. C. F. Farnell many interesting anecdotes pertaining to her father's life and work.

Laboratories Developments in New Downtown Building

The largest dial private branch exchange yet to be installed, designed by the Systems Development Department of the Laboratories, has been placed in the new 54-story City Bank Farmers Trust Building which was formally opened February 24. Enough central office equipment to serve a city of 50,000 persons is comprised in the installation which was provided by the New York Telephone Company.

Radiating from the combination dial and manual private branch exchange are 2,900 extension lines, 430 trunks, and 220 tie-lines to 40 other PBX's. Its 39 operators' positions and more than 1,000 associated line-finders, selectors and connectors are designed to handle 10,750 calls in an hour. It has an ultimate capacity in excess of 5,000 extension lines and the initial installation can serve around 2,900. The 430 trunk lines connect it with the Bowling Green central office from which it is served, and provide a group direct to the New York Long Distance center.

Standard step-by-step equipment of the central office type is employed for the dial end, and the manual switchboard is made from standard sections finished in walnut mahogany. The circuits are all new and were developed for this type of board by the Local Systems group on PBX circuits under R. W. Harper. Equipment details were worked out by the PBX Equipment group under H. D. Bruhn.

To supplement the PBX with facilities for transmitting written messages, the New York Telephone Company has also installed for the National City group a teletypewriter system involving ten machines. These interconnect the headquarters offices of the three affiliated companies and link with headquarters several of the larger branches.

An electrical protection system, also of Laboratories' origin, will guard the huge vaults of the City Bank Farmers Trust Company in the building. The system, known as the Western Electric detector system, consists of a number of delicate microphones installed in the walls of the vaults.

So sensitive are these instruments that they will give alarm at the slightest vibration passing through the massive steel and concrete walls. The system is based on the inertia micro-

phone developed in these Laboratories during the war period for the detection of submarines. As it has no diaphragm it is insensitive to sound waves. When actuated by vibrations, however, electric current is sent through a series of relays which transmits signals to the central office of the Holmes Electric Company which installed the system.

Colloquium

P. P. Cioffi addressed the Colloquium, February 2, on the subject *Hydrogenized Iron of High Magnetic Permeability.* He pointed out that recent experiments have led to the discovery that magnetic iron, heat-treated at high temperatures in hydrogen, acquires remarkable magnetic qualities, not unlike those of permalloy. Other magnetic materials, he said, also respond to this treatment. According to one hypothesis, the effect is due to the hydrogen absorbed, and according to another, it is due to the purification of the iron by the hydrogen. Mr. Cioffi presented experimental evidence for and against each of these hypotheses.

The new Western Electric 3-A Photoelectric Cell, developed in our Vacuum Tube Research Department, was discussed by C. H. Prescott in a talk delivered February 16 on the subject *The Photoelectric Effect in Two-Component Films of Oxygen and Caesium on Silver.* The variations in the amounts of caesium and oxygen upon the photoelectric properties of the new cell, and changes produced by varying the conditions of preparation were detailed by Mr. Prescott.

The meeting on March 2 was addressed by J. A. Becker on the subject *An Electrical Microscope.* He pointed out that the characteristics of a filament may be used to discern, for example, how much thorium there is on a tungsten surface; how this thorium is distributed over the surface; the size of the patches; and how the thorium moves over the surface.

ADMINISTRATION

Vice-President H. P. Charlesworth attended a District Meeting of the American Institute of Electrical Engineers held in Pittsburgh on March 11 and 12.

S. P. Grace addressed the supervisory employees of the Chesapeake & Potomac Bell Telephone Company of Virginia at Richmond, February 6, on recent communication developments. R. M. Pease also gave a brief account of Noise Abatement Surveys.

On February 17, Mr. Grace spoke under the auspices of the Chamber of Commerce before an audience of 2000 persons at Norfolk, Virginia. He was enthusiastically received, the Norfolk Ledger Dispatch in its editorial the next day asserting that "— far and away the best, the finest and most entertaining show of the season, or many seasons, was given — unfortunately, for one performance only — at the Wells Theatre last night, when Dr. Sergius P. Grace, of Bell Telephone Laboratories, Incorporated, revealed 'The Marvels of Sound Transmission.'"

At St. Louis on March 3 and 4 he spoke at the Odeon Theatre under the auspices of the Engineers Club of St. Louis. About 2,000 persons attended the meeting. He extended his trip into the southwest and spoke at Shrine Auditorium, Oklahoma City, on March 10. Mr. Grace's appearance in Oklahoma City was sponsored by the Engineers' Club and the Oklahoma Utilities Association.

Departmental News

Apparatus Development
Special Products

J. J. Kuhn was in Hollywood in connection with the production of sound pictures and conferred with West Coast engineers on recording problems.

E. T. Mottram has made several trips to Hawthorne on work in regard to the new re-recording machine.

R. Nordenswan was also at Hawthorne to discuss new developments on audiphones and loud-speaking telephones.

Harry Pfannenstiehl completed twenty years of service on March 14.

T. E. Shea described the new method of noiseless recording at the meeting of the Society of Motion Picture Engineers in our auditorium on February 27.

R. A. Miller and V. M. Cousins were in Buffalo as technical consultants in patent litigation involving theatre reproducing systems.

J. C. Barnes has returned from a five weeks' visit to Hawthorne in connection with problems on the film re-recording machine.

Radio Development

During the month a demonstration of Western Electric aviation radio telephone communication was made for the following members of the Police Commissioner's staff of the New York Police Department: Mr. Thomas W. Rochester, Chief Engineer; Mr. Arthur M. Chamberlain, Assistant to the Commissioner; and Captain A. W. Wallender, head of the Police Air Service Division.

The demonstration consisted of three-way conversations between the Ford airplane, the portable truck radio station and the aeronautical ground station at Mendham, New Jersey. Pilots A. R. Brooks and P. D. Lucas with W. A. Funda and D. B. McKey formed the crew of the airplane. J. M. Henry operated the truck radio station and J. P. Dolbear operated the ground station at Mendham.

A field intensity survey for the WGAR Broadcasting Company, Incorporated, of Cleveland, was conducted by A. B. Bailey.

A demonstration of Western Electric airplane radio-telephone communication was made for Mr. R. H. Milne, Radio and Electrical Projects Engineer, U. S. Navy, during a flight in the Laboratories' Fairchild airplane. Later in the month a similar demonstration was given for Mr. H. A. Robinson of the Northern Electric Company.

The Laboratories' Ford airplane was used in a Fox Movietone production of a sound picture made for the New York Police Department to illustrate the activities of its Aerial Police Force. A. R. Brooks and P. D. Lucas piloted the plane during the filming of this picture. R. J. Zilch acted as mechanic.

R. E. Coram visited Washington to testify as an expert witness before the Federal Radio Commission.

H. S. Price inspected the 5 kw.

radio telephone broadcasting equipment of the Stromberg-Carlson Telephone Manufacturing Company of Rochester, New York.

ON MARCH 2 the Liaison Committee on Aeronautic Radio Research, on which F. M. Ryan is serving as the representative of the Institute of Radio Engineers, met at the Laboratories under the Chairmanship of Colonel Harry H. Blee. The meeting was the first of the committee to be held outside of Washington. Later the members were guests of the Laboratories at luncheon and then were conducted on an inspection tour of the 463 West Street and Graybar-Varick laboratories. In addition to the committee members, O. B. Blackwell, L. Espenschied, and L. E. Whittemore of the A. T. & T. Co.; and R. L. Jones, H. D. Arnold, W. Wilson, E. L. Nelson and H. A. Frederick of the Laboratories were present at the luncheon.

F. M. Ryan's lecture graphically interpreted by Ohio members of the A.I.E.E.

F. M. RYAN addressed the local sections of the American Institute of Electrical Engineers at Toledo, Columbus and Cleveland, Ohio. His subject was *The Flying Telephone*. In his talk he described the important problems encountered in developing radio facilities for communication between aircraft and ground stations. The talk was illustrated by slides and a Western Electric sound picture showing aircraft radio-telephone equipment.

TELEPHONE APPARATUS

PROGRESS IN Electrical Communication was described by William Fondiller in a talk before the Brooklyn Institute of Arts and Sciences on March 10. Mr. Fondiller supplemented his remarks with an exhibition of lantern slides illustrating some recent developments in the Laboratories. Great interest was shown by the audience of about two hundred, judging by the many questions that were asked. A. L. Stillwell assisted in an exhibit of apparatus.

TRANSMISSION APPARATUS

W. J. SHACKELTON attended a meeting of the A.I.E.E. Sectional Committe on Electrical Definitions.

C. R. YOUNG inspected an installation of the new welded-type steel loading coil cases in Plainfield.

CONTINUING his observations of lacquer treated wire in telephone exchanges in various localities, O. C. Eliason visited Cleveland and Chicago in company with G. H. Downes of the American Telephone and Telegraph Company.

S. G. HALE went to Hawthorne in connection with the line assembly of loading coils.

ALSO AT HAWTHORNE F. P. D'Esopo conferred on and inspected the production and testing of various types of induction coils.

MATERIALS

J. R. TOWNSEND was in Pittsburgh, where he attended a meeting of the A.S.M.E. Special Research Committee on Mechanical Springs. The committee under the chairmanship of Mr. Townsend outlined a program for future research work.

W. W. WERRING was in Auburn,

New York, on various molding problems. He also visited Chicago in connection with work on transmitters.

Manual Apparatus

C. F. Swasey visited the plant of the Weston Electrical Instrument Company at Newark, in connection with meter problems.

L. N. Hampton was at Hawthorne on work connected with plug gauge and miscellaneous maintenance apparatus.

M. Whitehead visited the Philadelphia Repair Shop to discuss the repair of sound picture motors.

Dial Apparatus

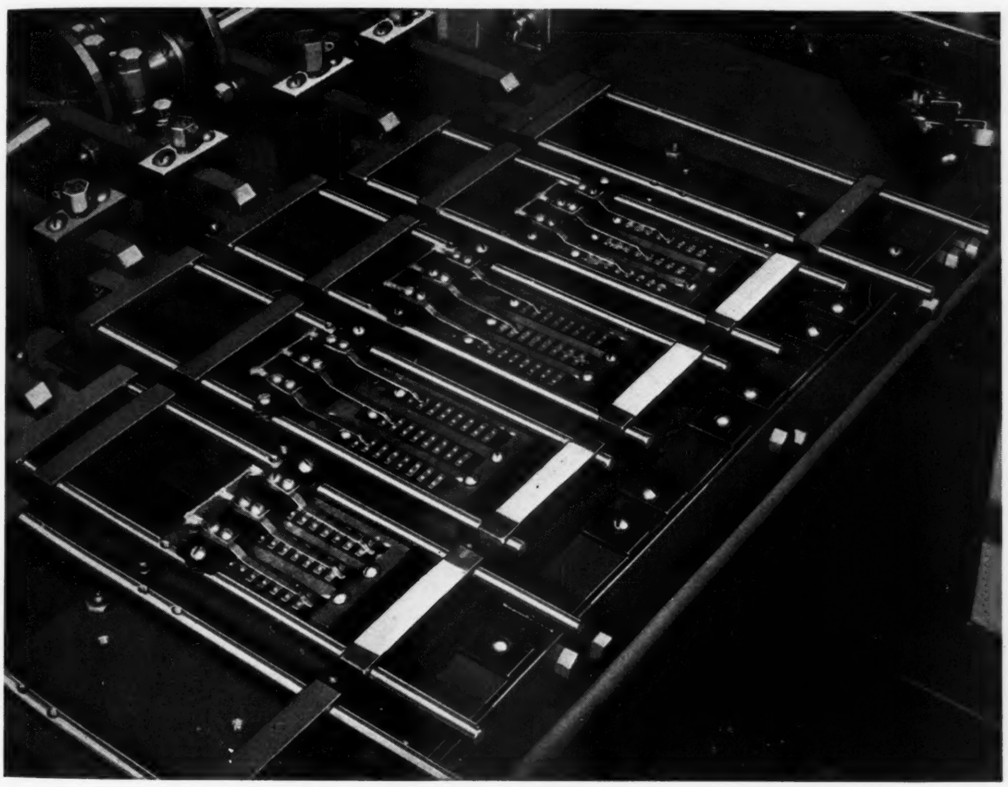
B. F. Runyon visited Pittsburgh and Chicago in connection with transmission tests on voice-frequency telegraph circuits between New York and Chicago.

D. D. Miller was in Hawthorne for conference on new relay developments.

PUBLICATION

Before the members of the University Cottage Club at Princeton, February 19, P. B. Findley described electrical transmission of sound and illustrated his remarks with a playing of several records of the Laboratories series.

L. S. O'Roark was twenty years a member of the Western Electric Company and Laboratories on March 20.



Reciprocating wear test machine: mechanical arms slide back and forth over banks of contact surfaces; by studying the wear on these surfaces it can be determined what materials are best suited for the large number of sliding contacts throughout the telephone system

PATENT

On February 19 U. S. Commissioner of Patents, Mr. Robertson, and the Assistant Commissioner, Dr. Kinnan, addressed the Patent Department at a luncheon and subsequently visited our Laboratories.

During February, J. G. Roberts spent several days in Buffalo in connection with patent litigation.

Routine patent matters required the presence in Washington of F. H. Crews, G. T. Morris and T. P. Neville.

From November 1, 1930 to February 1, 1931, patents were issued to the following:

P. H. Betts	A. C. Keller
H. S. Black	D. H. King
E. Bruce	C. D. Koechling
W. W. Carpenter	V. E. Legg
O. Cesareo	F. B. Llewellyn
A. M. Curtis	W. A. Marrison (3)
H. W. Dudley	H. T. Martin
B. G. Dunham	W. P. Mason (2)
O. C. Eliason	C. R. Moore
G. W. Elmen (2)	E. R. Morton (2)
F. S. Entz	L. A. Morrison
P. B. Flanders	E. L. Norton
M. E. Fultz	J. H. Penn
A. E. Hague	E. Peterson
H. C. Harrison (4)	W. T. Pritchard
R. V. L. Hartley	W. H. Scharringhausen
R. A. Heising (2)	G. H. Stevenson
R. E. Hersey	A. L. Thuras
E. T. Hoch	E. C. Wente
F. A. Hubbard	J. H. White (2)
A. G. Jenson	H. Whittle
K. S. Johnson (2)	C. F. Wiebusch

E. B. Wood

Equipment Development

Twenty-five years in the Bell System were completed by H. M. Hagland on March 7. He is a member of the PBX equipment group.

Mr. Hagland entered the employ of the Western Electric Company in the old Clinton Street, Chicago, factory and worked for a year on the inspection of subscriber's sets. He then went with the Chicago Telephone Company where he obtained a wide

H. M. Hagland

experience in telephone work. Until coming with the Western Electric engineering department in 1919 he worked on telephone installing, central office maintenance, local test work and switchboard repair.

As a member of the Equipment Development group of the Western Electric Company and Laboratories he has been engaged on the engineering of toll equipment, local operating desks, local test desks and general standard practices. He has been doing equipment engineering of PBX's since 1928.

G. A. Benson was in Philadelphia and Yonkers in connection with developments on pneumatic ticket distributing systems.

Dial Equipment Development

S. F. Butler and L. M. Allen visited Boston to confer with the engineers of the New England Telephone Company on the equipment now being

installed by that company for tandem operation by panel senders.

C. H. ACHENBACH attended a regular meeting of the Equipment Cost-Reduction Committee at Hawthorne.

THE FIRST regular installations of ringing and tone-supply equipment using the new tone alternator and mercury type interrupter have been made at Toledo, Cincinnati and Pittsburgh. C. W. Van Duyne visited these offices to inspect the new equipment and observe their operation under service conditions.

CHALMERS P. WELLS completed twenty years of service in the Bell System on March 3.

LOCAL SYSTEMS

L. M. ALLEN, Field Development Engineer, completed twenty-five years as a member of the Bell System on March 18. Mr. Allen came with the

L. M. Allen

Laboratories in 1919 from the New York Telephone Company.

His work in the telephone industry began as inside night maintenance man for the New York Telephone Company. He won advancement to regular and then senior inside night maintenance man and to assistant night wire chief. From 1912 to 1917 he was night wire chief for Manhattan and Bronx.

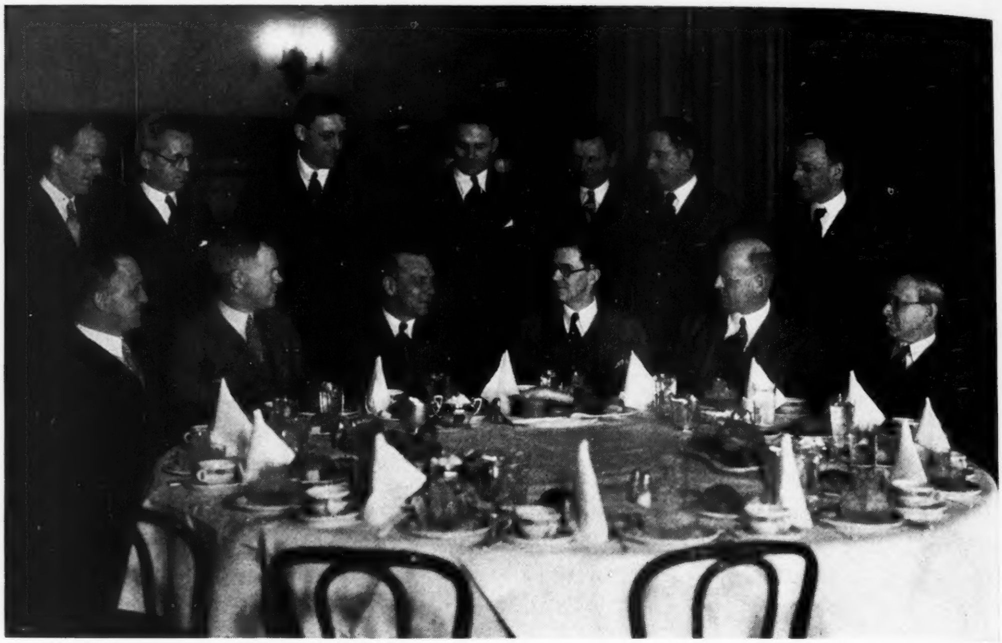
In 1918 he was assigned to the New Jersey Bell Telephone Company as a loaned employee to gather information on the operation of the semi-mechanical systems installed in the Mulberry, Waverly and Branch Brook offices. During the same year he was transferred to the Western Electric Company, still as a loaned employee, and in 1919 officially became a member of the Western Electric in the circuit design group. He was placed in charge of the test circuit design in 1923 and assumed his present duties as Field Development Engineer in 1928. He has charge of trial and initial installations of Local Systems Development projects.

An authority in central office maintenance, Mr. Allen while with the New York Telephone Company taught classes in maintenance practices and compiled a bulletin of maintenance instructions which was used for many years. During the winter of 1911-1912 he was sent to Buffalo, when the local company was taken over by the New York Telephone, to organize and train a night force in the methods that prevailed in New York City. He is co-author of a book on central office maintenance.

C. F. SEIBEL completed twenty years of service in the Bell System on March 6.

G. A. HURST was in Chicago during February to make observations and tests at the new tandem office.

W. J. LACERTE spent several days at Indianapolis investigating modified step-by-step office line switches, and visited Toledo to observe the first commercial installation of new trunk circuits.



Group at luncheon in honor of W. H. Matthies' thirty years of service: Seated, H. H. Lowry, L. F. Morehouse (A. T. & T.), W. H. Matthies, A. F. Dixon, B. W. Kendall, L. Keller. Standing, L. M. Allen, H. M. Bascom (A. T. & T.), W. L. Filer, W. E. Viol, J. L. Dow, F. J. Scudder, S. B. Williams

W. H. Matthies Guest at Anniversary Luncheon

On February 26 W. H. Matthies was guest of honor at a luncheon given by Mr. Dixon. The occasion was the thirtieth anniversary of Mr. Matthies' association with the Bell System which began when he became an office boy in the old Thames Street factory of the Western Electric Company.

As an office boy, he was alert, industrious, probably mischievous, and ambitious as office boys usually are, but with the vision and perseverance to carry out his ambitions. He realized that an engineering training was essential if he was to reach the mark set by his superiors in the telephone industry so he decided on a college course. He went to Cornell and a year later to Massachusetts Institute of Technology from which he was graduated in 1902.

Mr. Matthies returned to the Western Electric Company and worked two years on equipment development and apparatus design. He was sent to Germany in 1904 and later was attached to the European Chief Engineer's Staff of the Western Electric at Antwerp. He was forced to flee the latter city in 1914 as the German Army advanced across Belgium and went to London and then to Sweden and Norway where he was occupied for two years in building rotary automatic exchanges.

In 1916 he returned to this country as a member of the machine switching group in the Engineering Department of the Western Electric Company. He was placed in charge of the machine switching laboratory the following year. In 1919 he was

given supervision of machine switching circuits, to which was added manual circuits in 1920. Mr. Matthies assumed his present duties in charge of Local Systems Development in 1921.

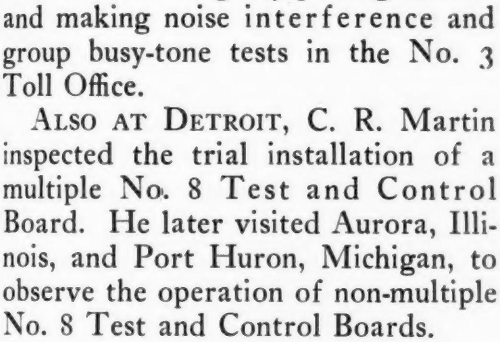
The greater portion of his thirty years in telephone work has been devoted to the development of dial systems, both panel and step-by-step. There is scarcely a feature in either system in whose design he has not had some part. In the contribution of ideas, the working out of mechanical details, the coordination and unification of the labors of others, he has been one of the outstanding leaders in bringing dial systems to their present state of efficient and exacting operation.

C. H. McCandless was in Boston to investigate the operation of panel office link circuits.

Toll Development

J. B. McKim spent several days in Detroit observing key pulsing circuits and making noise interference and group busy-tone tests in the No. 3 Toll Office.

Also at Detroit, C. R. Martin inspected the trial installation of a multiple No. 8 Test and Control Board. He later visited Aurora, Illinois, and Port Huron, Michigan, to observe the operation of non-multiple No. 8 Test and Control Boards.



F. F. Farnsworth attended meetings at Chicago of the Research Committee of the American Electroplaters' Society in connection with A. S. T. M. work on specifications relating to electroplated metal products. He also stopped at Detroit to discuss motor vehicle finishes with engineers of the Michigan Bell.

With C. C. Lawson Mr. Farnsworth made a second trip to the middle west to attend the meeting of the American Ceramics Society at Cleveland. While on this trip they also visited the conduit plant of the National Fireproofing Company.

C. R. Moore was at Hawthorne to discuss manufacturing problems relative to the new sleeve-rolling tool, cable-splicing machines, and binding-post cutters.

F. D. Waldron was at Morristown, New Jersey, to install cable terminals for cross-talk balancing in a trial on carrier toll cable.

L. W. Kelsay was at Point Breeze in connection with a new distribution cable terminal. He also made a trip to Philadelphia in regard to a proposed new type of cross-connecting cable terminal.

A trial installation of mechanical protection for underground cable near Morristown, New Jersey, was inspected by S. C. Miller and O. B. Cook in company with A. L. Fox, J. H. Gray, and J. D. James of the American Telephone and Telegraph Company.

L. H. Burns, with S. A. Haviland, H. F. Stover, J. A. Bowman, of the American Telephone and Telegraph Company was at Union, New Jersey, in connection with a trial installation of a new design of cable rack support.

V. B. Pike was at Morristown, New Jersey, to observe the construction of a vertical cable plug in a toll cable. Mr. Pike also visited Prince-

ton, New Jersey, to inspect the construction of a proposed type of paraffin plug to be used in making a cable transfer. Transfer with this plug is made with gas pressure constantly maintained and without appreciable loss of gas during the operation.

THE BURYING OF some experimental underground cable was inspected by W. E. Mougey in a recent trip to Ada, Oklahoma.

R. P. ASHBAUGH, Outside Plant representative at Hawthorne, was at Point Breeze and New York attending conferences on cable sheath and other cable development problems.

J. G. BREARLEY made a visit to Scranton to observe the installation of commercial cable with a new type of sheath.

INSPECTION ENGINEERING

A. F. GILSON visited various timber and creosote suppliers in several Southern States to arrange for quality surveys on yellow pine poles.

A. G. DALTON was in Atlanta during the latter part of February to introduce the Complaint Review Conference Plan in Division Three, Southern Area, Long Lines Department of the American Telephone and Telegraph Company. The plan is expected to be in operation in all Long Lines divisions by early November.

DURING FEBRUARY, A. J. Boesch, Field Engineer at Philadelphia, and R. C. Koernig, Field Engineer at Omaha, spent several days in New York discussing Field Engineering matters with various members of the Inspection Engineering Department.

STAFF DEPARTMENT

MEMBERS OF the Building Service force were saddened to learn of the death of Edward J. Growney, formerly operator of elevator C, which occurred March 10 in the Polyclinic Hospital, New York, following ten

E. J. Growney

days' illness of pneumonia. Mr. Growney had completed thirty years of service with the Western Electric Company on November 9 of last year and a summary of his activities was published in the December BELL LABORATORIES RECORD.

He was regarded with high esteem by his fellow workers in the Building Service Department and his many friends throughout the building, among all of whom his death was felt with a sense of distinct loss.

JOHN MIHALKO completed twenty years of service with the Western Electric Company and Laboratories on March 1.

JAMES E. KELLY of the Receiving Department completed twenty years of service on March 25.

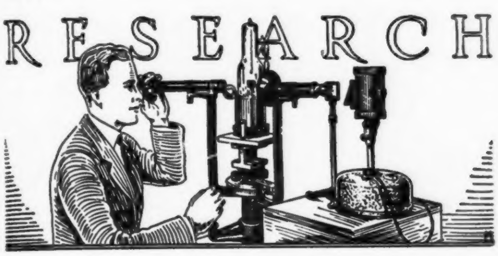
PATRICK MONAHAN, foreman in the Building Service Department, rounded out twenty-five years of service on March 20.

Mr. Monahan started as a sweeper in the shops of the Western Electric

Company and in 1913 was transferred to the operation of elevators.

Patrick Monahan

He was advanced to assistant foreman in 1920, which position he still holds.



CHEMICAL RESEARCH

J. H. INGMANSON and C. W. SCHARF visited the Point Breeze plant in connection with developments on rubber-covered wire.

C. S. FULLER visited Hawthorne in connection with the development of insulation testing methods for enamel wire.

A VISIT TO the Westfield exchange was made by H. G. Arlt, A. E. Schuh and C. C. Hipkins to examine a trial installation of markings on multiple jacks.

CABLE CORROSION was investigated by C. L. Hippensteel, C. W. Borgmann and R. B. Mears in a recent trip to Trenton and Philadelphia.

THE WOOD preservation and paint groups have moved to the laboratory at the corner of Park Avenue and Chestnut Street, Summit, New Jersey. The following men are included in the transfer: R. E. Waterman, H. Boving, K. G. Compton, C. S. Copeland, W. J. Clarke, R. H. Erickson, C. L. Erickson, C. J. Frosch, C. S. Fuller, C. M. Hill, L. V. Howard, H. E. Haring, C. E. Kempf, F. C. Koch, J. Leutritz, J. Linares, W. McMahon, R. F. Mosher, R. C. McGaffin, H. L. Nash, N. R. Pape, B. L. Rauschert, L. T. Smith, W. H. Stephens, and F. S. Winser.

R. E. WATERMAN and C. J. FROSCH attended the convention of the American Wood Preservers Association held at Philadelphia.

J. E. HARRIS was in Hawthorne to inspect the manufacturing processes of permalloy dust. J. H. White was also at Hawthorne on this work.

R. M. BURNS attended the Soil Corrosion conference held at the Bureau of Standards, Washington.

ELECTRO-OPTICAL RESEARCH

H. E. IVES spoke before the American Physical Society, February 28, on *Methods of Projecting Parallax Panoramagrams.*

E. F. KINGSBURY attended the lecture on Photoelectric Cells at the Franklin Institute, February 28, given by Dr. Zworykin.

K. K. DARROW spoke before the Georgia Academy of Science at Wesleyan College, Macon, Georgia, on February 13.

TRANSMISSION RESEARCH

L. G. KERSTA and R. O. WISE returned from Bradley, Maine, where they have been making measurements on wave antennas for transatlantic

radio-telephony using long waves.

Laboratory Engineering

A quarter of a century's service in the Bell System was completed by William F. Mayes on March 25. Mr. Mayes is a member of the Laboratory Equipment division of the Research Department, engaged in the wiring and assembling of apparatus.

His first telephone work was with the New York Telephone Company,

W. F. Mayes

assembling and wiring desk telephones from 1906 to 1909. He was transferred to similar work on subscriber's sets in 1909 and was made a gang foreman in the monitor department a year later. In 1914 he became assistant foreman in the subscriber's sets department. He came to the present West Street building when the New York Telephone Shop was moved here in 1914 and became a member of the Engineering Department of the Western Electric Company in 1915.

During the war period Mr. Mayes was engaged in wiring work on telephone and telegraph apparatus used by the Signal Corps in France. Following the close of hostilities he was assigned to his present work for the Research Department. He wired and assembled the amplifiers for the short-wave stations at Deal Beach and Rocky Point, and has performed wiring work on numerous other important Research Department projects.

Acoustical Research

Harvey Fletcher took part in the Eastern Zone Conference of the American Federation of Organizations for the Hard of Hearing at Springfield, February 20. He also attended a meeting of the American Association to Promote the Teaching of Speech to the Deaf held at the Volta Bureau, Washington.

Submarine Cable

E. T. Burton and E. W. Waters were in Key West February 2-20, making interference tests on the Key West-Havana Cable.

Radio and Vacuum Tube

W. Wilson has been elected chairman of the Papers Committee and has been re-appointed to the Board of Editors of the Institute of Radio Engineers. He is also a member of the Institute committees on Bibliography, Standardization, and chairman of the Technical Committee on Transmitters.

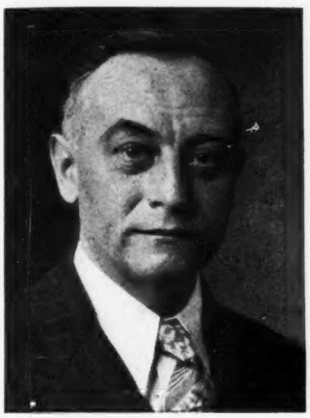
E. J. Sterba of the Deal radio laboratories delivered a talk *Theoretical and Practical Design of Transmitting Antennas* before the Philadelphia section of the Institute of Radio Engineers on February 11, 1931. Loyd E. Hunt, Phillip H. Smith, G. V. Dale, T. J. Hickley and G. M. Eberhardt of Deal attended the meeting.

A paper on *Ship to Shore Radio Telephone Systems* was read by F. R. Lack before the Communication

Group of the New York Section A.I. E.E., meeting in the Auditorium on March 10.

TRANSMISSION INSTRUMENTS

CHARLES WIDMAIER of the Instrument Standards group in the Graybar-Varick building completed thirty years in the Western Electric Company and the Laboratories March 18. His work has been devoted almost entirely to the adjustment and test of special



C. Widmaier

telephone receivers and transmitters. During his thirty years' connection with the Bell System, he has not only seen marked advance in the design of transmitters and receivers but also a considerable improvement in the methods of testing as a result of which machine methods of tests have been developed in the Laboratories and have almost entirely replaced voice methods in the Manufacturing Department.

From 1901 to 1907 he inspected and tested transmitters and receivers manufactured by the Western Electric Company in the building now occupied by the Laboratories. For the next seven years he was connected with a group responsible for the inspection of transmitter carbon and electrodes. When the manufacture of telephone instruments was moved to Hawthorne, he transferred to the Engineering Department and since that time he has engaged in the testing and calibration of the instrument standards which are used in the determination of the efficiency of transmitters not only in the Laboratories but also in our Manufacturing Department, repair shops, etc.

A VISIT TO the Norfolk Navy Yard was made by H. C. Pauly and J. T. L. Brown in company with F. C. Hogan of the Western Electric Company February 16 to 19. They assisted representatives of the U. S. Navy and the Bureau of Standards in tests of battle-telephone equipments installed on the *Arizona* and *Chester*.

DURING THE WEEK of February 22 H. A. Frederick, W. C. Jones and H. A. Larlee visited the Hawthorne works where they conferred with engineers of the Manufacturing Department on supply of coal for transmitter carbon, and other transmitter matters.

H. E. FRACKER visited the Victor Talking Machine Company at Camden, New Jersey, in regard to pressings of the new No. 8 Record of the Laboratories series.

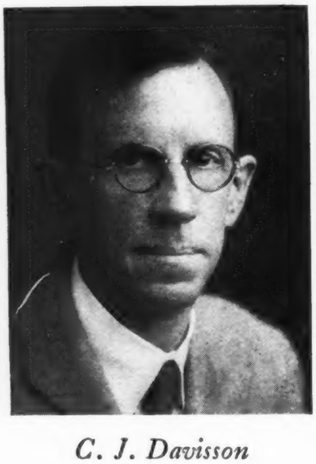
Contributors to this Issue

C. J. DAVISSON received a B.Sc. from the University of Chicago in 1908 and a Ph.D. from Princeton in 1911. The next six years he spent as instructor in physics at the Carnegie Institute of Technology and joined the Technical Staff of the Laboratories in 1917. With the Research Department he has been engaged in fundamental investigations in thermionics and electronic physics.

D. K. GANNETT received a B.S. in engineering from the University of Minnesota in 1916 and an E.E. degree in 1917. He at once joined the Engineering Department of the American Telephone and Telegraph Company and became a member of the D. & R. when that department was organized two years later. During the war he was engaged in the development of amplifiers for submarine-cable telegraphy, and since then has been occupied with transmission development problems relating to toll line signalling, vacuum tubes, telephotography, and — more recently — with the synchronized operation of radio broadcast stations. He has been engaged also in line-transmission studies for television ever since the beginning of that development.

S. T. CURRAN left Cornell Univerity in 1917, his senior year, to enlist in the Naval Reserve Flying Corp, and served overseas as an officer and airplane pilot engaged in convoy and submarine search operations. Returning to civil life in 1919 he held a position with the Army Ordinance Department appraising machinery and equipment of munition manufactures until joining the Laboratories in December, 1919. He has since been engaged in the design and development of central office apparatus.

FOR slightly more than a year in 1923-1924 F. B. Woodworth was a member of the Research Department. He left in September, 1924 for Schenectady and started on the Electrical



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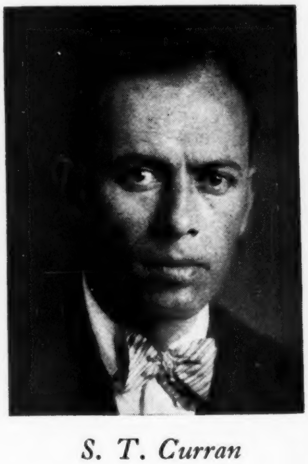

S. T. Curran

F. B. Woodworth

W. B. Snow

G. Puller

Engineering course at Union College. For three summers while at college he worked with the New York Telephone Company. Following his graduation in 1928 he became a member of the Radio Development group and worked on radio-beacon and aircraft radio-telephone development at Hadley Field. At present he is engaged on the development of radio-telephone apparatus for harbor craft. Mr. Woodworth's trip to Alaska in connection with a trial installation of the radio telephone on the fishing boats of Libby, McNeil and Libby, described in this issue, took place during the past summer from May 9 to August 5.

W. B. Snow is a graduate of Stanford University with A.B. and E.E. degrees. He became associated with the Laboratories in 1923 and left nearly a year later for further studies at Stanford. In 1925 he returned to the Laboratories as a member of the Acoustical Research group. He has been engaged chiefly on investigations of distortion in speech and music.

G. Puller received a B.S. degree in mechanical engineering from Cooper Union in 1912 and an equivalent degree in electrical engineering three years later. In 1916 the post-graduate degree of M.E. was conferred upon

P. Husta

W. L. Heard

him. He joined the engineering department of the Western Electric Company in 1920 and spent two years designing household appliances. Following this he transferred to the Apparatus Development Department where he was engaged in the design of radio receivers and later of power-line carrier apparatus. Since 1926 he has been active in the design and development of reproducing equipment for sound pictures.

In 1918, during his sophmore year, P. Husta left the College of the City of New York to join the Laboratories as a technical assistant. Shortly after, however, he enrolled in the Student Army Training Corps at New York University. On being discharged from service in the spring of 1919 he returned to the Laboratories where he engaged in ringing and low-frequencies studies with the Local Systems Department. He was a member of the first class completing the course for technical assistants. Early in 1928 he was made supervisor of a group responsible for testing interconnecting circuits of the Panel System and for making fundamental pulsing studies.

After obtaining the degree of B.S.E.E. from Kansas State College in 1911, W. L. Heard entered the employ of the Automatic Electric Company in Chicago. The next year, however, he became affiliated with the Western Electric Company in Hawthorne and remained with it until 1919 when he transferred to the Laboratories. Both at the Hawthorne plant and in New York, his field of work has been equipment engineering.

A Recent Accession to the Museum

Deep sea section of the first successful Atlantic telegraph cable, laid in 1866. The core consists of a strand of seven copper wires each of No. 18 B.W.G., coated with four layers of gutta-percha alternating with four of Chatterton's compound. Next is a cushion of tanned jute and over this there are wound spirally ten homogeneous galvanized iron wires No. 13 B.W.G. Each wire is separately covered with five strands of Manila yarn